



## Higher National Unit specification

### General information for centres

**Unit title:** Cellular Signalling

**Unit code:** DP4T 35

**Unit purpose:** This Unit is designed to provide candidates with an understanding of the main aspects of cellular signalling and, by using selected disease states, to develop an understanding of what happens when errors in signalling occur.

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

- 1 Describe the molecular mechanisms of cell signalling.
- 2 Explain the signalling mechanisms in the nervous systems.
- 3 Outline the major concepts of molecular pharmacology.
- 4 Discuss the molecular pharmacology of selected disease states.

**Credit points and level:** 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 is at the discretion of the centre, however, it is recommended that candidates should have achieved the HN Unit: Cell Biology: Theory and Practice (DJIK34).

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

**Context for delivery:** If this Unit is delivered as part of a Group Award, 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 by a holistic, closed-book, supervised assessment with evidence for the knowledge and skills in this Unit being provided on a sample basis. Outcome 4 could alternatively be assessed separately by means of a case study in which Outcomes 1-3 should be assessed holistically.

## Higher National Unit specification: statement of standards

**Unit title:** Cellular Signalling

**Unit code:** DP4T 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

Describe the molecular mechanisms of cell signalling

#### Knowledge and/or Skills

- ◆ general principles of cell signalling
- ◆ receptors
- ◆ G proteins
- ◆ effectors
- ◆ second messengers
- ◆ termination of signal

#### Evidence Requirements

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

- ◆ identify the general principles of cell signalling in terms of reception, transduction and response
- ◆ describe the structure of receptors and the different categories with respect to mechanisms of signal transduction
- ◆ describe the structure of G proteins and their role in signal transduction
- ◆ describe the different types of effectors
- ◆ identify a range of second messenger molecules and describe their effects within a cell
- ◆ explain how cellular signals are terminated

For this Outcome at least three of the six knowledge and skills items listed above must be assessed on each occasion.

Evidence should be gathered using a written/oral assessment under closed-book supervised conditions. Assessment for this Outcome could be done in a single holistic end of Unit assessment for all Outcomes

#### Assessment Guidelines

This assessment could take the form of a set of short answer or restricted response questions. Candidates should obtain 60% of the marks available in order to pass this assessment.

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

**Unit title:** Cellular Signalling

### Outcome 2

Explain the signalling mechanisms in the nervous systems

#### Knowledge and/or Skills

- ◆ nature of nerve signals
- ◆ synaptic structure and function
- ◆ modulation of synaptic transmission
- ◆ types of neurotransmitters
- ◆ synthesis, release and inactivation of neurotransmitters

#### Evidence Requirements

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

- ◆ explain how a nerve signal is generated
- ◆ relate synaptic structure to function
  - describe the physical structure of synapses
  - explain how synapses function
- ◆ explain the modulation of synaptic transmission
- ◆ describe the major classes of neurotransmitters and explain how they function
- ◆ explain the pre-synaptic synthesis of neurotransmitters, role of vesicles and termination of neurotransmitter signals

Evidence should be gathered using a written/oral assessment under closed-book supervised conditions. Assessment for this Outcome could be done in a single holistic end of Unit assessment for all Outcomes.

For this Outcome at least three of the five knowledge and skills items listed above must be assessed on each occasion.

#### Assessment Guidelines

This assessment could take the form of a set of short answer or restricted response questions. Candidates should obtain 60% of the marks available in order to pass this assessment.

### Outcome 3

Outline the major concepts of molecular pharmacology

#### Knowledge and/or Skills

- ◆ agonists and antagonists
- ◆ affinity, efficacy and potency
- ◆ dose response curves
- ◆ target molecules

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

### Unit title: Cellular Signalling

#### Evidence Requirements

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

- ◆ distinguish between the terms agonist and antagonist
- ◆ define the terms affinity, efficacy and potency
- ◆ explain the functions of a dose response curve
  - outline the uses of a dose response curve
  - accurately plot and interpret dose response curves
- ◆ explain the consequences of targeting drugs at specific molecules in a signalling pathway

For this Outcome at least two of the four knowledge and skills items listed above must be assessed on each occasion. In addition candidates must plot graphs of dose response curves or carry out calculations involving interpretation of data from dose response curves.

Evidence should be gathered using a written/oral assessment under closed-book supervised conditions. Assessment for this Outcome could be done in a single holistic end of Unit assessment for all Outcomes

#### Assessment Guidelines

This assessment could take the form of a set of short answer or restricted response questions. Candidates should obtain 60% of the marks available in order to pass this assessment.

### Outcome 4

Discuss the molecular pharmacology of selected disease states

#### Knowledge and/or Skills

- ◆ Neurotransmission and Parkinson's Disease
- ◆ Neurotransmission and Schizophrenia
- ◆ Cell signalling and Cancer
- ◆ Cell signalling and Diabetes Mellitus

#### Evidence Requirements

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

- ◆ identify the signalling error in Parkinson's disease and discuss the pharmacological approaches to treating this condition
- ◆ describe the signalling error in schizophrenia and discuss the physiological consequences of this fault
- ◆ discuss the currently identified signalling errors in cancers
- ◆ describe the insulin signalling pathway and discuss errors in type 1 and type 2 diabetes mellitus

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

### **Unit title:** Cellular Signalling

For this Outcome at least two of the four knowledge and skills items listed above must be assessed on each occasion. One which must be a neurotransmitter and one cell signalling.

Evidence should be gathered using a written/oral assessment under closed-book supervised conditions. Assessment for this Outcome could be done in a single holistic end of Unit assessment for all Outcomes.

### **Assessment Guidelines**

This assessment could take the form of a set of short answer or restricted response questions testing. Candidates should obtain 60% of the marks available in order to pass this assessment.

Outcome 4 lends itself to a report or a case study to put the subject into context..

## Administrative Information

**Unit code:** DP4T 35  
**Unit title:** Cellular Signalling  
**Superclass category:** PB  
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### History of changes:

Version	Description of change	Date
02	Changes made to standardise assessment guidelines.	03/06/09

**Source:** SQA

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## Higher National Unit specification: support notes

### Unit title: Cellular Signalling

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 candidates with an understanding of the main aspects of cellular signalling and, by using selected disease states, to develop an understanding of what happens when errors in signalling occur. The emphasis should be on the recurring features of signalling pathways; for example the receptor/ G protein/effector principle, as the field is rapidly changing and detail will change during the lifetime of this Unit. However it is equally important that candidates learn sufficient detail to allow them to be able to interpret data in terms of cellular signalling and also to be able to explain the known and theoretical consequences of errors developing at different stages in the pathways.

**Outcome 1** focuses on the molecular mechanism of cell signalling. The knowledge and/or skills which should be covered are:

- ◆ General principles: the three stages of cell signalling (reception; transduction; response), amplification of signals, intracellular effect of extracellular messengers.
- ◆ Receptors: functional domains, G protein-coupled receptors, tyrosine kinase receptors, ligand-gated and voltage-gated ion channel receptors, intracellular receptors.
- ◆ G proteins: alpha, beta and gamma subunits, GTPase activity, subtypes, role in transduction.
- ◆ Effectors: adenylate cyclase, guanylate cyclase, ion channels, phospholipases, kinases.
- ◆ Second messengers: cyclic AMP, cyclic GMP, calcium ions, diacyl glycerol, inositol phosphates.
- ◆ Termination of signal: phosphodiesterases, phosphatases.

**Outcome 2** focuses on the signalling mechanism in the nervous system. The knowledge and/or skills which should be covered are:

- ◆ Nature of nerve signals: membrane potential, ion channels, depolarisation, action potential.
- ◆ Structure/functioning: chemical and electrical synapses, synaptic clefts, pre- and post-of synapses: synaptic membranes, ionotropic and metabotropic post-synaptic receptors.

## Higher National Unit specification: support notes

### Unit title: Cellular Signalling

- ◆ Modulation of synaptic neural integration, EPSP and IPSP, temporal and spatial transmission: summation.
- ◆ Neurotransmitters: cholinergic, aminoacidergic (eg GABA, glutamine), monoaminergic (eg dopamine, noradrenaline, adrenaline, serotonin), purinergic (eg adenosine), nitric oxide.
- ◆ Synthesis/vesicles/inactivation: synthesis; synthesis pathways. Vesicles; active zones, role of  $\text{Ca}^{2+}$  ions, synaptic docking and fusion, exocytosis. Inactivation; transporter proteins, reuptake, inactivation enzymes (eg acetylcholinesterase).

**Outcome 3** focuses on some of major concepts of molecular pharmacology. The knowledge and/or skills which should be covered are:

- ◆ Agonists and antagonists: full and partial agonists, competitive antagonists
- ◆ Affinity, efficacy and potency: drug/receptor interaction, qualitative efficacy, quantitative potency, desensitisation, hypersensitivity.
- ◆ Dose-response curves: determining  $E_{\max}$ , determining  $EC_{50}$  for full agonists +/- antagonists, defining  $ED_{50}$ ,  $TD_{50}$ , therapeutic index,  $LD_{50}$ .
- ◆ Target molecules: drug targets at level of receptor; intermediate steps in pathway; drugs that interfere with termination of signal.

**Outcome 4** focuses on the molecular mechanism of selected diseases. The knowledge and/or skills which should be covered are:

- ◆ Parkinson's disease: dopamine, dopamine pathways, damage to nerve cells in basal ganglia, L-DOPA, phentothiazine drugs.
- ◆ Schizophrenia: monoamine neurotransmitters (noradrenaline, dopamine, serotonin), receptors [especially D2 dopamine receptors and 5HT (hydroxyl tryptamine) receptors], neurotransmitter processing (monoamine transporters, monoamine oxidase, catechol-O-methyl transferase).
- ◆ Cancer: oncogenes and proto-oncogenes, signalling proteins encoded by oncogenes (growth factor receptors, *src*, *raf*, *ras*, *myc*, *fos*, *jun*), signalling proteins and the cell cycle, signalling proteins and programmed cell death.
- ◆ Diabetes: insulin hormone, insulin receptor (structure and function), tyrosine kinase activity, IRS (insulin receptor substrates), PI3 kinases, role of  $\text{PIP}_3$ , PDK1 and substrates, glucose transport proteins (especially GLUT4), insulin insensitivity, treatment of Type 1 and Type 2 conditions.

## **Higher National Unit specification: support notes**

**Unit title:** Cellular Signalling

### **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 reassessment 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: Cellular Signalling**

This is a 1 credit HN Unit at SCQF level 8 designed for candidates undertaking a Biomedical Science qualification. It is designed to provide you with an understanding of the main aspects of cellular signalling and, by using selected disease states, to develop an understanding of what happens when errors in signalling occur.

On completion of this Unit you should be able to:

- 1 Describe the molecular mechanisms of cell signalling.
- 2 Explain the signalling mechanisms in the nervous systems.
- 3 Outline the major concepts of molecular pharmacology.
- 4 Discuss the molecular pharmacology of selected disease states.

### **The four Outcomes which make up the Unit are described below:**

#### **Outcome 1**

Here the general principles of cell signalling will be introduced. The lectures/tutorials for this Outcome will focus on recurring themes in signalling pathways. Here you will learn how extracellular signals cause intracellular changes in the target cell.

#### **Outcome 2**

In this Outcome you will study the signalling mechanisms of the nervous system, primarily focusing on how synaptic transmission occurs and the chemicals used in this event.

#### **Outcome 3**

This Outcome looks at some of the major concepts of molecular pharmacology such as the difference between agonists and antagonists and how you would determine the effective concentration of a pharmaceutical. Here you will be required to plot graphs and interpret the data they present.

#### **Outcome 4**

In the final Outcome of this Unit you will be able to utilise the knowledge from earlier Outcomes to investigate the signalling defects associated with conditions such as Parkinson's disease and cancer.

Your knowledge of the topics covered in this Unit will be assessed by a holistic closed-book, where in order to pass, you will need to achieve at least 60% of the marks available. The test will be composed of short-answer/restricted response questions.