Higher National Unit specification

General information

Unit title: Cellular Signalling (SCQF level 8)

Unit code: H928 35

Superclass: PB

Publication date: May 2015

Source: Scottish Qualifications Authority

Version: 01

Unit purpose

This Unit is designed to provide learners 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 learner will be able to:

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

Credit points and level

1 Higher National Unit credit at SCQF level 8: (8 SCQF credit points at SCQF level 8)

Recommended entry to the Unit

Entry is at the discretion of the centre, however, it is recommended that learners should have achieved the HN Unit H927 34 *Cell Biology: Theory and Laboratory Skills*.

Higher National Unit specification: General information (cont)

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Core Skills

Opportunities to develop aspects of Core Skills are highlighted in the Support Notes for this Unit specification.

There is no automatic certification of Core Skills or Core Skill components in this Unit.

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.

Equality and inclusion

This Unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website **www.sqa.org.uk/assessmentarrangements**.

Higher National Unit specification: Statement of standards

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Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

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. Learners 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

Outcome 2

Explain the signalling mechanisms in the nervous system.

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

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)

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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 for this Unit

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

Where evidence for Outcomes is assessed on a sample basis, learners 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

Where an item is sampled, a learner's response will be judged satisfactory where the evidence provided is sufficient to meet the requirements for each item by showing that the learner 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/or Skills items listed above must be assessed on each occasion.

Higher National Unit specification: Statement of standards (cont)

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Outcome 2

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

For this Outcome at least three of the five Knowledge and/or Skills items listed above must be assessed on each occasion.

Outcome 3

Where an item is sampled, a learner's response will be judged satisfactory where the evidence provided is sufficient to meet the requirements for each item by showing that the learner 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/or Skills items listed above must be assessed on each occasion. In addition learners must plot graphs of dose response curves or carry out calculations involving interpretation of data from dose response curves.

Outcome 4

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

For this Outcome at least two of the four Knowledge and/or Skills items listed above must be assessed on each occasion.

Higher National Unit Support Notes

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Unit Support Notes are offered as guidance and 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 learners 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 learners 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 — Describe the molecular mechanisms 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.

Higher National Unit Support Notes (cont)

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Outcome 2 — Explain the signalling mechanisms 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.
- 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 Ca^{2+} ions, synaptic docking and fusion, exocytosis. Inactivation; transporter proteins, reuptake, inactivation enzymes (eg acetylcholinesterase).

Outcome 3 — Outline the 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.

Higher National Unit Support Notes (cont)

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Outcome 4 — Discuss the molecular pharmacology of selected disease states

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 5 HT (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 PIP_3, PDK1 and substrates, glucose transport proteins (especially GLUT4), insulin insensitivity, treatment of type 1 and type 2 conditions.

Guidance on approaches to delivery of this Unit

This Unit forms part of the HND Applied Biological Sciences Group Award, which is primarily designed to prepare learners for employment in a laboratory science related post. The Unit requires the learner to be familiar with cell biology and hence it is expected to be delivered subsequent to HN Units in *Cell Biology: Theory and Laboratory Skills* and *Human Body Structure and Function* in the HND Applied Biological Sciences programme. Where possible during the delivery, links should be drawn with other relevant areas of the course, eg chemistry of neurotransmitters, and biochemistry of enzyme action. The use of learner-centred, resource-based methodologies should be as extensive as possible to promote independent study.

Guidance on approaches to assessment of this Unit

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to learners.

This Unit should be assessed by a holistic, closed-book, supervised assessment with evidence for the Knowledge and/or Skills in this Unit being provided on a sample basis. The assessment could take the form of a set of short answer or restricted response questions. Learners should obtain 60% of the marks available in order to pass the assessment.

Outcome 4 could alternatively be assessed separately by means of a report or case study to put the subject into context, in which Outcomes 1−3 should be assessed holistically.

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

Opportunities for e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at **www.sqa.org.uk/e-assessment**.

Opportunities for developing Core and other essential skills

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

History of changes to Unit

Version	Description of change	Date

General information for learners

Unit title: Cellular Signalling (SCQF level 8)

This is a 1 credit HN Unit at SCQF level 8 designed for learners undertaking an HN 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 system.
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

The general principles of cell signalling will be introduced. The lectures/tutorials for this Outcome will focus on recurring themes in signalling pathways. 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. 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 assessment.