Higher National Unit Specification

General information

Unit title: Cell Biology: Theory and Laboratory Skills (SCQF level 7)

Unit code: J2RE 34

Superclass: RH

Publication date: November 2019

Source: Scottish Qualifications Authority

Version: 02

Unit purpose

This unit is designed to enable learners to understand key aspects of cell biology. Learners will also develop practical skills in techniques relevant to cell biology. The unit is suitable for learners studying at HNC level, and will provide the necessary underpinning knowledge and skills to enable progression to further study of biology at HND level or to seek employment in science-based industries.

Outcomes

On successful completion of the unit the learner will be able to:

1 Describe and explain the structure and function of the eukaryotic cell membrane and cell organelles.
2 Describe protein processing and degradation.
3 Describe and explain cellular communication.
4 Describe and explain cell replication and division.
5 Perform a practical experiment related to cell biology.

Credit points and level

1 Higher National Unit credit at SCQF level 7: (8 SCQF credit points at SCQF level 7).

Recommended entry to the unit

Entry is at the discretion of the centre, however it is recommended that learners should have completed the HN Unit H923 33 *Biology: An Introduction* or equivalent, or have experience of Biology at Higher level.

Higher National Unit Specification: General information (cont)

Unit title: Cell Biology: Theory and Laboratory Skills (SCQF level 7)

Core Skills

Achievement of this Unit gives automatic certification of the following Core Skills component:

Core Skill component Critical Thinking at SCQF level 5

Any opportunities to develop further aspects of Core Skills are highlighted in the Support Notes section of this Unit specification.

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.

The Assessment Support Pack (ASP) for this unit provides assessment and marking guidelines that exemplify the national standard for achievement. It is a valid, reliable and practicable assessment. Centres wishing to develop their own assessments should refer to the ASP to ensure a comparable standard. A list of existing ASPs is available to download from SQA's website **(http://www.sqa.org.uk/sqa/46233.2769.html)**.

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

Unit title: Cell Biology: Theory and Laboratory Skills (SCQF level 7)

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 and explain the structure and function of the eukaryotic cell membrane and cell organelles.

Knowledge and/or skills

- Structure and function of the eukaryotic cell membrane: protein and lipid components
- Factors which affect the fluidity of the eukaryotic cell membrane
- Structure and function of common eukaryotic cell organelles

Outcome 2

Describe protein processing and degradation.

Knowledge and/or skills

- Processing of proteins through the secretory pathway and in the cytoplasm
- Post-translational modifications of proteins
- Processes of protein degradation: ubiquitination, autophagic and lysosomal pathways

Outcome 3

Describe and explain cellular communication.

Knowledge and/or skills

- Local communication between neighbouring cells and the structures involved
- Chemical and electrical communication between cells that are distally located
- Disease states associated with errors in communication

Higher National Unit Specification: Statement of standards (cont)

Unit title: Cell Biology: Theory and Laboratory Skills (SCQF level 7)

Outcome 4

Describe and explain cell replication and division.

Knowledge and/or skills

- Phases and control of the cell cycle
- Mitosis and meiosis
- Onset of cancerous cells

Outcome 5

Perform a practical experiment related to cell biology.

Knowledge and/or skills

- Cell biology experiment
- Working safely, within current health and safety regulations
- Consistent and accurate results
- Recording observations and results
- Evaluation skills
- Result analysis and conclusion

Evidence requirements for this unit

Written and/or oral recorded evidence for Outcomes 1–4 should be assessed using a holistic closed-book assessment under supervised conditions. The assessment will use a sampling approach to the knowledge and/or skills as detailed below. It is recommended that the assessment be completed within one hour.

Written and/or oral recorded evidence for Outcome 5 should be assessed by production of a full laboratory report, completion of an appropriate pro forma or a laboratory diary entry.

Outcome 1

The assessment will sample two of the three knowledge and/or skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (re-sit) assessment.

Where an item is sampled, a learner's response will be judged satisfactory where the evidence shows that the learner can:

- describe the structure and function of the eukaryotic cell membrane: protein and lipid components.
- explain factors which affect the fluidity of the eukaryotic cell membrane.
- describe the structure and function of common eukaryotic cell organelles.

Higher National Unit Specification: Statement of standards (cont)

Unit title: Cell Biology: Theory and Laboratory Skills (SCQF level 7)

Outcome 2

The assessment will sample two of the three knowledge and/or skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (re-sit) assessment.

Where an item is sampled, a learner's response will be judged satisfactory where the evidence shows that the learner can:

- describe the processing of proteins at free ribosomes and the rough endoplasmic reticulum.
- describe post-translational modifications of proteins.
- describe one form of protein degradation: ubiquitination, autophagic or lysosomal.

Outcome 3

The assessment will sample two of the three knowledge and/or skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (re-sit) assessment.

Where an item is sampled, a learner's response will be judged satisfactory where the evidence shows that the learner can:

- describe local cell-to-cell communication structures and their function between neighbouring cells.
- describe communication between distally located cells: chemical or electrical.
- explain the pathogenesis of one disease associated with signalling errors from distally located chemical, distally located electrical or local signalling.

Outcome 4

The assessment will sample two of the three knowledge and/or skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (re-sit) assessment.

Where an item is sampled, a learner's response will be judged satisfactory where the evidence shows that the learner can:

- describe the phases and control of the cell cycle.
- describe the stages of mitosis or meiosis.
- explain the onset of cancerous cells.

Higher National Unit Specification: Statement of standards (cont)

Unit title: Cell Biology: Theory and Laboratory Skills (SCQF level 7)

Outcome 5

Learners will perform a minimum of one practical experiment, the content of which will be related to Outcomes 1–4. A learner's response will be judged satisfactory where the evidence shows that the learner can achieve all of the following:

- Follow instructions to perform an experiment related to cell biology.
- Work in a safe manner regarding current health and safety regulations.
- Achieve consistent and accurate results.
- Record experimental observations and results clearly and accurately.
- Evaluate validity of results in terms of sources of and values of experimental errors.
- Analyse results correctly and state valid conclusions.

An assessor observation checklist will be used to record the learner's performance of the practical work in line with given instructions and health and safety requirements.

Learners may report results either by production of a full laboratory report, completion of an appropriate pro forma or a laboratory diary entry. Where a pro forma approach is deployed, the pro forma will not present information or assistance to the learners on how to correctly perform calculations, analyse experimental results or experimental errors. Learners will be expected to perform such activities independently on the basis of the experimental data. Where a laboratory diary approach is deployed, the laboratory diary must meet all of the requirements of a pro forma (in particular an evaluation of experimental errors), as set out in the Understanding Standards materials.

Where a learner does not perform an assessed practical experiment to the required standard, they will be given the chance to either reattempt the same practical experiment, or to undertake a different practical experiment of similar complexity. Where a laboratory report, pro forma or laboratory diary does not meet the required standard, then the learner will be given a single opportunity to re-draft. If the required standard is still not attained, then an alternative practical experiment will be set.

Higher National Unit Support Notes

Unit title: Cell Biology: Theory and Laboratory Skills (SCQF level 7)

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 intended as part of the framework for HNC/HND Applied Sciences, HND Applied Biological Sciences and HND Applied Chemical Sciences but may be suitable for inclusion in other HN science awards. It is designed to develop the theoretical and practical aspects of cell biology.

Outcome 1 — Describe and explain the structure and function of the eukaryotic cell membrane and cell organelles.

The cell membrane forms a barrier between the external environment and the internal contents of a cell. The fluid mosaic model composed of lipid and protein components with hydrophobic and hydrophilic regions should be described. Main lipid components being phospholipids which are amphipathic in nature and are arranged to form the bilayer structure of the membrane. The protein components may be integral (span membrane) or peripheral (do not span membrane) and serve to function as enzymes, receptors, transporters, for cell recognition, for cell adhesion or attachment to the cytoskeleton.

The fluidity of the membrane is important to allow adaptation to the environment and may be altered by factors such as the degree of polyunsaturated/saturated lipids, cholesterol content in eukaryotic cells and by varying temperature.

Eukaryotic (plant and animal) organelles are membrane bound although they vary in composition. Common organelles such as the nucleus and nucleolus, rough and smooth endoplasmic reticulum, Golgi apparatus, mitochondria, chloroplasts, lysosomes, peroxisomes and vacuoles have a particular structure in order to allow them to contribute to the functionality of the cell. Cytoskeleton proteins provide a structural framework for the cell and provide a set of tracks for newly synthesised proteins and organelles (microtubules), provide tensile strength and anchorage (intermediate filaments) and are involved in cell division (microtubules and actin).

Higher National Unit Support Notes (cont)

Unit title: Cell Biology: Theory and Laboratory Skills (SCQF level 7)

Outcome 2 — Describe protein processing and degradation.

The fate of a newly synthesised protein is determined by the presence and location of a signal peptide. The majority of proteins are fully translated at free ribosomes in the cytoplasm and if they lack a signal sequence they are released and remain in the cytosol. If they are destined for the nucleus, mitochondria, chloroplasts or peroxisomes they will bear an organelle specific signal sequence and be targeted to the specific organelle for import. Proteins bearing an ER signal peptide at their N-terminal are recognised by the signal recognition particle (SRP) which targets them to the ribosomes attached to the rough endoplasmic reticulum for completion of translation. Upon entry to the secretory pathway, the signal peptide is removed by signal peptidase and enters the lumen of the endoplasmic reticulum (ER) if it is hydrophilic (soluble) in nature. If the protein has hydrophobic regions (ie destined to be an integral membrane protein) it will remain embedded in the ER membrane and be transported through the secretory pathway to its ultimate destination via vesicular trafficking. Destinations may be to a lysosome, the cell membrane for secretion or to be embedded in the cell or organelle membranes.

Proteins may be post-translationally modified to aid their correct folding, targeting to sub-cellular organelles and for their functionality. Common modifications are glycosylation (to aid cellular location), phosphorylation (for activity) or proteolytically cleaved to become functional (eg insulin from pancreatic β-cells).

Organelles and proteins are constantly subject to quality control. If deemed non-functional or redundant they may be degraded. The most common pathways include ubiquitination, autophagic and lysosomal.

Outcome 3 — Describe and explain cellular communication.

Cells can communicate with neighbouring cells by direct contact. The structures that facilitate these communication pathways include gap junctions (composed of a tubular structure of six connexins on each cell joining to directly link the cytoplasm), tight junctions, plasmodesmata and desmosomes. Local signalling can also be distributed between neighbouring cells through second messengers (including cAMP and Ca^{2+}) and cytokines.

Signals can be passed to distally located cells through electrical impulses carried by neurones or by chemical (hormone) messengers through the bloodstream. Examples of hormone signalling includes anti-diuretic hormone (ADH), insulin and growth hormone and convey the general concept of reception, transduction and response. For electrical signalling specific neurotransmitters could be discussed such as noradrenaline or acetylcholine and how they lead to the generation of an action potential, transmission of the signal and response.

Many diseases arise due to problems in signalling. Diseases and their errors in communication should relate to errors in distally located hormonal signalling (eg Type 1 and Type 2 diabetes), errors in distally located electrical signalling (eg multiple sclerosis) and errors in local signalling (eg congenital deafness). Centres may cover other diseases at their discretion to enhance learning and understanding. Examples include pituitary dwarfism, Parkinson's disease and myasthenia gravis.

Higher National Unit Support Notes (cont)

Unit title: Cell Biology: Theory and Laboratory Skills (SCQF level 7)

Outcome 4 — Describe and explain cell replication and division.

The purpose of the cell cycle is for a cell to accurately duplicate its genetic material and organelles to produce two identical daughter cells. Mammalian cells will initiate cell division in response to extracellular signals called mitogens. The phases of the cell cycle include G0/G1, S, G2 and M phases. Regulation of the movement through the cycle is controlled by varying levels of complexes of cyclin and cyclin dependent kinase (CdK) proteins where their activity is controlled by phosphorylation/dephosphorylation events. Delivery should focus on the cyclic pattern of these complexes as opposed to named specifics for each phase. Other cell cycle controls are DNA damage checkpoints and spindle fibre checkpoints to ensure the correct replication and division of DNA.

Mitosis forms the M-phase of the cell cycle. Stages are: interphase, prophase, metaphase, anaphase, telophase and cytokinesis. Where mitosis maintains chromosomal number (diploid in humans) meiosis serves to half the chromosomal number to allow for the formation of gametes. Maternal and paternal gametes fuse at the point of fertilisation and result in a diploid zygote; maintaining ploidy number within the human species. Stages of meiosis are: prophase I, metaphase I, anaphase I, telophase I, prophase II, metaphase II, anaphase II, telophase II and cytokinesis.

Cancer may arise when cell replication and division goes wrong or becomes uncontrolled. Movement through the cell cycle is controlled by proto-oncogenes and tumour suppressor genes which respectively promote or inhibit progression through the cycle. If either gene type becomes mutated this leads to oncogenes encoding oncoproteins resulting in uninhibited cell proliferation and an abnormal mass of cells (tumour). An example of a tumour suppressor protein is p53 which serves to halt the cell cycle if DNA damage is detected; and if irreparable will induce apoptosis (programmed cell death). Loss of function mutated forms of p53 exist in many types of cancer.

Outcome 5 — Perform a practical experiment related to cell biology.

Guidance on suitable practical experiments for assessment purposes is given elsewhere in this document. However, it is envisaged that learners will also participate in a range of other practical experiments which will both develop their laboratory skills and support the theory covered in Outcomes 1–4.

In carrying out such activities, learners should follow Good Laboratory Practice (GLP) and carry out or be familiar with the risk and Control of Substances Hazardous to Health (COSHH) assessments on all procedures undertaken. Opportunities should be taken to develop awareness of the sources of experimental error and of the accuracy of measurements, with quantification of errors where possible.

Higher National Unit Support Notes (cont)

Unit title: Cell Biology: Theory and Laboratory Skills (SCQF level 7)

Guidance on approaches to delivery of this unit

Outcomes 1–3 would best be delivered in order. Outcome 4 could be delivered either side of Outcomes 1–3. It is envisaged that laboratory work and demonstrations will feature across each of the outcomes.

Outcome 1 is intended to cover the molecular structure and function of the eukaryotic cell membrane and organelles. Delivery could commence with a brief description of the cell membrane and its role in separating the cytoplasm from the external environment and as a permeability barrier. This could then be followed by introduction of the fluid mosaic model; a section describing the chemical structure of the main membrane lipids (phospholipids and cholesterol) and the protein components, in terms of hydrophilic and hydrophobic domains leading to orientation of the lipid bilayer and integral/peripheral proteins respectively. Practical work in this section could be used to illustrate the functions of the membrane as a permeable barrier.

The protein components may be explained in terms of their location in the lipid bi-layer. Intergral proteins spanning part or all (transmembrane) of the bi-layer or sitting on the bi-layer (cystolically or externally). A general overview of their varying functions could then be explained as enzymes, receptors, transporters, for cell recognition, for cell adhesion or attachment to the cytoskeleton. The fluid mosaic model could be reinforced with learners producing detailed labelled drawings of all the components.

Delivery of the outcome could then focus on the continuation of the lipid structure, establishing that the cell membrane is a bi-layer and that these lipid molecules are laterally mobile in the membrane. This could then lead on to factors which affect the fluidity of the membrane, including a description of the role of polyunsaturated/saturated lipids with varying lengths and chemical bonds, the cholesterol content and alterations in temperature in the surrounding environment.

A general description of common eukaryotic animal and plant cells could then be given. Common organelles being the nucleus and the nucleolus, rough and smooth endoplasmic reticulum, Golgi apparatus, mitochondria, chloroplasts, lysosomes, peroxisomes and vacuoles. Cytoskeleton proteins should be briefly introduced with no need to cover detail on the formation of these fibres.

The delivery of Outcome 2 should make reference to the organelles delivered in Outcome 1. The focus is the processing of proteins and their ultimate destination within the cell and the role of the signal peptide in determining this fate.

Newly synthesised proteins destined for the cytosol, nucleus, mitochondria, chloroplasts and peroxisomes are fully translated at ribosomes freely floating in the cytoplasm. The lack of a signal sequence (cytosolic proteins) or the presence of an organelle specific sequence will target their final cellular location. Proteins destined to be embedded into the cell or organelle membranes (link to integral and membrane proteins) or for a lysosome will bear an ER signal peptide which will be detected by the SRP and targeted to the rough endoplasmic reticulum where translation will be completed. Reference should be made to the specific enzyme, signal peptidase and translocons in this process. Specific organelles/components of the secretory pathway could then be covered. Specific proteins could be discussed; insulin made within pancreatic β-cells would be a good example as it can also be used as a specific example for proteolytic cleavage for post translational modification and also its role as a hormone which acts as a signalling molecule in Outcome 3. The fate of the protein can be traced from its synthesis, processing, secretion and then action.

When organelles and proteins are no longer needed, these proteins must be degraded. There are various methods for this, including; ubiquitination, the autophagosome pathway and lysosome degradation.

Delivery of Outcome 3 could commence with a description of the structures and mechanisms involved in local signalling and distance signalling pathways, explaining how a response is achieved through the various pathways. There may be opportunities to allow group work where each group is set a task to research the pathogenesis of a particular disease and to determine the causative error in the pathway. Learners work could then be brought together and consolidated to aid peer-led learning.

The diseases to be taught/researched are at the discretion of the centre. However, delivery should cover local signalling communication errors and distance (chemical and electrical) signalling communication errors. Congenital deafness (connexon 26 mutation), Type 1 and Type 2 diabetes and multiple sclerosis are examples which cover the necessary criteria.

Delivery of Outcome 4 could commence with the phases of the cell cycle with the cycle being triggered by receipt of an extracellular signal. An explanation of the events which occur throughout each phase should be given highlighting the cyclic pattern of cyclin-CdK activity for progression through the cycle and also checkpoint control measures. The stages of the M (mitosis) phase could be taught via an allium root tip practical which would then lead into meiosis.

An explanation of when cell replication and division goes wrong and when quality control checkpoints fail would lead into the topic of the onset of cancerous cells. The concept of tumour suppressor proteins and oncoproteins could be introduced using the named example of p53. Centres may wish to teach other specifically named examples such as the mutated Retinoblastoma (Rb) protein or the Ras protein.

It is envisaged that Outcome 5 will be delivered alongside the theoretical based Outcomes 1–4. A range of practical experiments could be utilised to both support understanding of the underlying theory and to prepare learners for undertaking the assessed practical experiment.

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.

Outcomes 1–4 could be assessed by a single holistic closed-book assessment with an appropriate cut-off score that covers the sampling requirements as detailed in the evidence requirements. Assessment should be carried out in supervised conditions, and it is recommended that the assessment be completed within 60 minutes.

Where evidence of Outcomes 1–4 is assessed by sampling, the whole of the content listed in the knowledge and/or skills 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. Any items not sampled in the first assessment must be included in the alternative (re-sit) assessment.

Higher National Unit Support Notes (cont)

Unit title: Cell Biology: Theory and Laboratory Skills (SCQF level 7)

In Outcome 5 learners are required to undertake a minimum of one assessed practical experiment, the content of which will be related to Outcomes 1–4. Examples of suitable experiments are given below. However, this list is not prescriptive, and other practical experiments of similar complexity may be used by the centre.

Suitable practical experiments for Outcome 5 are:

- Comparing structure and size of plant and animal cells
- Simple staining of animal cheek cells, onion cells or guard cells
- Haematoxylin and Eosin staining of tissue sections
- Differential centrifugation of organelles
- Disruption of the cell and vacuole membranes in beetroot/red cabbage cells
- Identification of secretory pathway organelles on electron micrographs
- Allium root staining
- Calculating Mitotic index

Assessed practical experiments will usually be performed individually. However, there may be some experiments that are suitable to be undertaken in pairs or small groups. If this is the case then the assessor should ensure that all participants are actively involved and are able to adequately demonstrate the required skills.

An exemplar instrument of assessment with marking guidelines has been produced to indicate the national standard of achievement at SCQF level 7.

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**.

Higher National Unit Support Notes (cont)

Unit title: Cell Biology: Theory and Laboratory Skills (SCQF level 7)

Opportunities for developing Core and other essential skills

The Critical Thinking component of Problem Solving at SCQF level 5 is embedded in this unit. When a learner achieves the unit, their Core Skills profile will also be updated to include this component.

The delivery and assessment of this unit will provide learners with the opportunity to develop the Core Skills of *Numeracy* at SCQF level 6 and *Information and Communication Technology (ICT)* at SCQF level 4.

Numeracy — Using Number at SCQF level 6

Learners will be required to decide on the steps and operations to solve complex problems, carrying out sustained and complex calculations, eg performing calculations related to cell size.

Information and Communication Technology (ICT) — Providing/Creating Information at SCQF level 4

Learners could make effective and appropriate use of ICT packages to produce laboratory reports or pro formas in an appropriate format as well as preparing group results from an investigation. Packages used will likely include word processing, spreadsheets, and graph drawing software. Learners will also be required to utilise internet search engines to source information on research topics.

Sustainability

Sustainability can be embedded in delivery of the unit in a variety of ways. For example, by encouraging minimum usage, correct disposal procedures and possibly recycling during practical experiments.

History of changes to unit

Version	Description of change	Date
02	Core Skills Component Critical Thinking at SCQF level 5 embedded.	19/11/19

General information for learners

Unit title: Cell Biology: Theory and Laboratory Skills (SCQF level 7)

This section will help you decide whether this is the unit for you by explaining what the unit is about, what you should know or be able to do before you start, what you will need to do during the unit and opportunities for further learning and employment.

This is a 1 credit unit at SCQF level 7, which you are likely to be studying as part of the first year of an HNC/HND science programme. Before progressing to this unit it would be beneficial to have experience of Biology at Higher level or to have completed the HN Unit H923 33 *Biology: An Introduction*, where you will have learned underpinning aspects of cell biology and developed your practical skills.

On completion of the unit you should be able to:

1 Describe and explain the structure and function of the eukaryotic cell membrane and cell organelles.
2 Describe protein processing and degradation.
3 Describe and explain cellular communication.
4 Describe and explain cell replication and division.
5 Perform a practical experiment related to cell biology.

Outcome 1

In this outcome you will learn that the cell membrane separates the cell from the external environment as well as forming the barrier of internal organelles, serving as a permeability barrier. You will learn about the fluid mosaic model and the main lipid molecules and the features of membrane proteins. You will also learn about the common organelles within a cell.

Outcome 2

In this outcome you will discover how proteins are folded and transported to the cell surface when synthesised in the rough endoplasmic reticulum as well as the fate of proteins synthesised in the cytoplasm. You will learn how they are modified after they are synthesised. In addition, you will cover how proteins are removed from the cell in various ways.

Outcome 3

In this outcome you will focus on how cells communicate both locally with neighbouring cells and those cells distally located. Cells can communicate over distances using electrical impulses (through neurones) or chemical messengers. You will also learn that many disease conditions arise due to problems in signalling.

Outcome 4

In this outcome you will learn about the phases a cell goes through when it wants to replicate and divide, and the ways in which it controls this division and ensures that it happens correctly. You will learn how the cell duplicates its chromosomes and how it halves the number of chromosomes to produce gamete type cells. You will also learn how cancerous cells develop.

General information for learners

Unit title: Cell Biology: Theory and Laboratory Skills (SCQF level 7)

Outcome 5

In this outcome you will undertake a practical experiment, based on the content of Outcomes 1–4.

During this practical work, you will also be expected to develop good laboratory practices as well as improve your skills of manipulation, observation and measurement. You will also be encouraged to develop safe working practices and to strive constantly to improve the accuracy and reliability of your results. The reporting and analysis of experimental data is an important aspect of the practical sessions.

Assessment

For Outcomes 1 to 4 you will take a closed-book, end of unit assessment.

Outcome 5 will be assessed after you have learned the necessary practical skills, and will take the form of a minimum of one practical experiment, for which you will report your results either in a full laboratory report, a pro forma report or a laboratory diary entry.

Core Skills

Although there is no automatic certification of Core Skills in the unit, you will have opportunities to develop the Core Skills of *Numeracy* at SCQF level 6 and *Information and Communication Technology (ICT)* at SCQF level 4.