SCQF level 5
Unit Specification

Cell Biology

SCQF: level 5 (6 SCQF credit points)

Unit code: H207 75

Unit outline

The general aim of this Unit is to develop skills of scientific inquiry, investigation and analytical thinking, along with knowledge and understanding of cell biology. Learners will apply these skills when considering the applications of cell biology on our lives, as well as the implications on society/the environment. This can be done by using a variety of approaches, including investigation and problem solving.

The Unit covers the key areas of: cell structure; transport across cell membranes; producing new cells; DNA and the production of proteins; proteins and enzymes; genetic engineering; photosynthesis and respiration. Learners will research issues, apply scientific skills and communicate information related to their findings, which will develop skills of scientific literacy.

Learners who complete this Unit will be able to:

1 Apply skills of scientific inquiry and draw on knowledge and understanding of the key areas of this Unit to carry out an experiment/practical investigation
2 Draw on knowledge and understanding of the key areas of this Unit and apply scientific skills

This Unit is available as a free-standing Unit. The *Unit Support Notes* in the Appendix provide advice and guidance on delivery, assessment approaches and development of skills for learning, skills for life and skills for work. Exemplification of the standards in this Unit is given *in Unit Assessment Support*.

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Recommended entry

Entry to this Unit is at the discretion of the centre. However, learners would normally be expected to have attained the skills, knowledge and understanding required by one or more of the following or equivalent qualifications and/or experience:

- National 4 Biology Course or relevant component Units

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. For further information, please refer to the Appendix: *Unit Support Notes.*

Standards

Outcomes and assessment standards

Outcome 1

The learner will:

1 Apply skills of scientific inquiry and draw on knowledge and understanding of the key areas of this Unit to carry out an experiment/practical investigation by:

1.1 Planning an experiment/practical investigation
1.2 Following procedures safely
1.3 Making and recording observations/measurements correctly
1.4 Presenting results in an appropriate format
1.5 Drawing valid conclusions
1.6 Evaluating experimental procedures

Outcome 2

The learner will:

2 Draw on knowledge and understanding of the key areas of this Unit and apply scientific skills by:

2.1 Making accurate statements
2.2 Solving problems

Evidence Requirements for the Unit

Assessors should use their professional judgement, subject knowledge and experience, and understanding of their learners, to determine the most appropriate ways to generate evidence and the conditions and contexts in which they are used.

The key areas covered in this Unit are: cell structure; transport across cell membranes; producing new cells; DNA and the production of proteins; proteins and enzymes; genetic engineering; photosynthesis and respiration.

Evidence can be drawn from a variety of sources and presented in a variety of formats.

The following table describes the evidence for the assessment standards which require exemplification. Evidence may be presented for individual outcomes, or gathered for the unit. If the latter approach is used, it must be clear how the evidence covers each outcome.

Assessment Standard	**Evidence required**
Planning an experiment/practical investigation	The plan should include: ♦ an aim ♦ a dependent and independent variable ♦ key variables to be kept constant ♦ measurements/observations to be made ♦ the resources ♦ the method including safety considerations
Presenting results in an appropriate format	One format from: table, line graph, chart, key, diagram, flow chart, summary or other appropriate format
Drawing a valid conclusion	Include reference to the aim
Evaluating experimental procedures	Suggest an improvement with justification
Making accurate statements	At least half of the statements should be correct across the key areas of this Unit.
Solving problems	One of each: ♦ make generalisations/predictions ♦ select information ♦ process information, including calculations, as appropriate ♦ analyse information

Exemplification of assessment is provided in *Unit Assessment Support*. Advice and guidance on possible approaches to assessment is provided in the Appendix: *Unit Support Notes.*

Assessment Standard Thresholds

Outcome 1

Candidates are not required to show full mastery of the assessment standards to achieve outcome 1. Instead, five out of the six assessment standards for outcome 1 must be met to achieve a pass. Candidates must be given the opportunity to meet all assessment standards. The threshold has been put in place to reduce the volume of re-assessment where that is required.

Transfer of evidence

Evidence of outcome 1 in a unit is transferrable between the other units at SCQF level 5.

Re-assessment

Candidates can be given the opportunity to re-draft their original outcome 1 report or to carry out a new experiment/practical investigation.

Outcome 2

There is no requirement to pass assessment standard 2.1 (making accurate statements) and assessment standard 2.2 (solving problems) independently. Candidates can be assessed using a single test that contains marks and a cut-off score.
A suitable unit assessment will cover all of the key areas (assessment standard 2.1) **and** assess each of the problem-solving skills (assessment standard 2.2).

Where a candidate achieves 50% or more of the total marks available in a single unit assessment, they will pass outcome 2 for that unit. Existing unit assessment support packs (UASPs) can be used, or centres can replace the questions with suitable alternatives of a similar standard.

Unit assessment support pack 1 (unit-by-unit approach) contains questions on all of the key areas (AS 2.1) and questions covering each of the problem solving skills (AS 2.2), and may be adapted for use as a single assessment. The number of marks available for each question should be combined to give the total number of marks available. A cut-off score of 50% should be applied to the unit assessment.

Outcome 2 assessment activity 2 tests contain questions covering assessment standards 2.1 and 2.2 in a single assessment.

Unit assessment support pack 2 (combined approach) contains questions covering only assessment standard 2.1. They are not suitable for use as a single assessment. If a centre choses to use UASP 2 as a single unit assessment, questions covering each of the four problem solving skills would need to be added. The marks available for the key areas (AS 2.1) should be combined with the marks added to assess the problem solving skills (AS 2.2) before the 50% cut-off score is applied. Where centres are adding additional questions, care should be taken that these questions are of an appropriate standard for unit assessment and are not ‘A grade’ type questions.

Important note: Centres can continue to assess AS 2.1 and 2.2 separately using the existing UASPs. If this option is chosen, 50% or more of the KU statements (AS 2.1) made by candidates must be correct in the unit assessment and at least one correct

response for each problem solving skill (AS 2.2) is required to pass outcome 2. However, if a candidate is given more than one opportunity in a unit assessment to provide a response for a problem solving skill, then they must answer 50% or more correctly.

Re-assessment

SQA's guidance on re-assessment is that there should only be one or, in exceptional circumstances, two re-assessment opportunities. Re-assessment should be carried out under the same conditions as the original assessment. It is at the teacher or lecturer's discretion how they re-assess their candidates. Candidates may be given a full re-assessment opportunity, or be re-assessed on individual key areas and/or problem-solving skills. As there is no requirement to pass assessment standard 2.1 (making accurate statements) and assessment standard 2.2 (solving problems) independently, candidates must achieve 50% of the marks available in the re-assessment.

Development of skills for learning, skills for life and skills for work

It is expected that learners will develop broad, generic skills through this Unit. The skills that learners will be expected to improve on and develop through the Unit are based on SQA's *Skills Framework: Skills for Learning, Skills for Life and Skills for Work* and drawn from the main skills areas listed below. These must be built into the Unit where there are appropriate opportunities.

2 Numeracy

2.1 Number processes
2.2 Money, time and measurement
2.3 Information handling

5 Thinking skills

5.3 Applying
5.4 Analysing and evaluating

Amplification of these is given in SQA's *Skills Framework: Skills for Learning, Skills for Life and Skills for Work.* The level of these skills should be at the same SCQF level of the Unit and be consistent with the SCQF level descriptor. Further information on building in skills for learning, skills for life and skills for work is given in the Appendix: *Unit Support Notes.*

Appendix 1: Unit support notes

Introduction

These support notes are not mandatory. They provide advice and guidance on approaches to delivering and assessing this Unit. They are intended for teachers and lecturers who are delivering this Unit. They should be read in conjunction with:

- the *Unit Assessment Support packs*

Developing skills, knowledge and understanding

Teachers and lecturers are free to select the skills, knowledge, understanding and contexts which are most appropriate for delivery in their centres.

Approaches to learning, teaching

Cell Biology		
key areas	**Suggested learning activities**	**Exemplification of key areas**
1 Cell structure Cell ultrastructure and functions to include: cell wall, mitochondrion, chloroplast, cell membrane, cytoplasm, vacuole, nucleus, ribosome and plasmid using examples from typical plant, animal, fungi and bacterial cells. Cell wall structure in fungal and bacterial cells is different from plant cells, ie not cellulose.	Examine fresh and prepared slides of a range of plant, animal and microbial cells using appropriate stains and a light microscope/ bioviewer, eg cheek epithelium, onion epidermis, rhubarb epidermis, Elodea, yeast. Numeracy activities on cell size to investigate cell length and breadth.	Functions of structures exemplified later in this Unit. Fungal structure in terms of similarity to plant and animal cells but with a different cell wall structure. Bacterial structures only to include absence of organelles and a different cell wall structure to plant and fungal cells. Chemical composition of cell walls for fungi and bacteria not required.
2 Transport across cell membranes a. The cell membrane consists of phospholipids and proteins and is selectively permeable. b. Passive transport is down a concentration gradient and does not require energy. c. Diffusion in cells as the movement of molecules down a concentration gradient.	Investigate the structure of the fluid mosaic model. Investigate diffusion and osmosis using visking tubing and/or mass/length of plant tissue, bleeding in plant cells, plant cell plasmolysis, mass changes in egg (shell removed by soaking in vinegar) in syrup/water.	Different concentrations of substances exist between cells and their environment. Diffusion in terms of concentration gradients and importance to cells

Cell Biology		
key areas	**Suggested learning activities**	**Exemplification of key areas**
d. Osmosis is the movement of water molecules from a high water concentration to a lower water concentration through a selectively permeable membrane. e. Animal cells can burst or shrink and plant cells can become turgid or plasmolysed in different solutions. f. Active transport requires energy for membrane proteins to move molecules and ions against the concentration gradient.	Research examples of osmosis for, eg power generation, desalination. Differential uptake of dye in boiled and live yeast cells.	could include glucose, carbon dioxide, oxygen or amino acids. Appropriate examples for active transport could include sodium and potassium in nerve cells, or iodine in seaweeds. These processes can be applied across relevant areas of the Course.
3 Producing new cells a. Sequence of events of mitosis (including the terms chromatids, equator and spindle fibres).	Select and present information using mitosis stage cards. Create model chromosomes. Observe prepared root tip cell slides/bioviewer.	Names of mitosis phases are not needed.

Cell Biology		
key areas	**Suggested learning activities**	**Exemplification of key areas**
b. Maintenance of diploid chromosome complement by mitosis. c. Mitosis is required for growth and repair. d. Cell production by cell culture requires aseptic techniques, an appropriate medium and the control of other factors.	Carry out numeracy activities based on cell growth graphs/curves. Practical activity/investigation/research into aseptic techniques, solid and liquid media in cell culture and use of fermenters.	Diploid cells have two matching sets of chromosomes, which are replicated during mitosis. Appropriate growth media include various nutrient broths and agars. Appropriate factors could include oxygen, temperature and pH. Examples of how to achieve aseptic conditions.
4 DNA and the production of proteins a. Structure of DNA: double-stranded helix held by complementary base pairs. DNA carries the genetic information for making proteins. The four bases Adenine, Cytosine, Guanine and Thymine (A, C, G and T) make up the genetic code. A is always paired with T and C is always paired with G. The base sequence determines amino acid sequence in protein. b. Messenger RNA (mRNA) is a molecule which carries a complementary copy of the	Research the relationship between chromosomes, genes, DNA and protein to illustrate that genes are located on chromosomes. Construction of 2D or 3D DNA models. Paper models of base pairing or DNA sections. Carry out numeracy activities to determine base pair numbers. Research biologists, eg Watson and Crick, Rosalind Franklin, Maurice Wilkins, Chargaff.	Knowledge of Uracil as a base in mRNA is not required.

Cell Biology		
key areas	**Suggested learning activities**	**Exemplification of key areas**
code from the DNA, in the nucleus, to a ribosome, where the protein is assembled from amino acids.		Further details of transcription and translation are not required.
5 Proteins and enzymes a. The variety of protein shapes and functions arises from the sequence of amino acids. b. Functions of proteins to include structural, enzymes, hormones, antibodies and receptors. c. Enzymes function as biological catalysts and are made by all living cells. They speed up cellular reactions and are unchanged in the process. The shape of the active site of an enzyme molecule is complementary to its specific substrate(s). Enzyme action results in product(s). Enzymes can be involved in degradation and synthesis reactions. Examples should relate enzymes to their specific substrate(s) and product(s). d. Each enzyme works best in its optimum conditions. Enzymes and other proteins can be affected by temperature and pH. Enzymes can be denatured, resulting in a change in	Create protein models, eg haemoglobin, antibodies, membrane proteins and enzymes. Use of appropriate software, eg RasMol, Protein Explorer. Enzyme experiments with, eg pepsin, lipase, amylase, catalase to investigate the influence of temperature and pH on activity.	Levels of protein structure such as secondary/tertiary not required.

Cell Biology		
key areas	**Suggested learning activities**	**Exemplification of key areas**
their shape, which will affect the rate of reaction.	Effect of temperature and pH on egg white as a model for effect on other proteins.	
6 Genetic engineering Genetic information can be transferred from one cell to another naturally or by genetic engineering. Stages of genetic engineering to include: identify section of DNA that contains required gene from source chromosome, extract required gene, extract plasmid from vector/bacterial cell, insert required gene into vector/bacterial plasmid, insert plasmid into host cell and grow modified cells to produce a genetically modified (GM) organism. Use of enzymes in this process.	Research current genetic foods/issues such as golden rice, less toxic rape seed oil, bird resistance to bird flu, tomatoes with longer shelf life, blight resistant potatoes, production of medicines for human use, eg insulin and growth hormone.	DNA can be transferred naturally between cells either by bacterial plasmids or viruses. Details of these processes not required. Names of particular enzymes are not required. Links with *Life on Earth* Unit.
7 Photosynthesis a. Photosynthesis is a two-stage process. 1. Light reactions: the light energy from the sun is trapped by chlorophyll in the chloroplasts and is converted into chemical energy in the form of ATP. Water is split to produce hydrogen and oxygen. Hydrogen attaches to hydrogen acceptor molecules. Excess oxygen diffuses from the cell.	Oxygen production, carbon dioxide uptake or rate of photosynthesis can be investigated through the use of floating leaf discs, Elodea, Cabomba or immobilised algae. These can also be used to investigate limiting factors. Use IT simulations of photosynthesis experiments, eg Multimedia Science	Summary word equation for photosynthesis: Carbon dioxide + water $\xrightarrow{\text{Light energy, Chlorophyll}}$ sugar + oxygen

Cell Biology		
key areas	**Suggested learning activities**	**Exemplification of key areas**
2. Carbon fixation: a series of enzyme-controlled reactions, which use hydrogen and ATP (produced by the light reactions) with carbon dioxide to produce sugar. b. The chemical energy in sugar is available for respiration or can be converted into other substances, such as starch (storage) and cellulose (structural). c. Limiting factors: carbon dioxide concentration, light intensity and temperature and their impact on photosynthesis and plant growth. Analysis of limiting factors graphs.	Factors affecting starch production can be investigated through iodine testing in leaves.	
8 Respiration a. The chemical energy stored in glucose must be released by all cells through a series of enzyme-controlled reactions called respiration. b. The energy released from the breakdown of glucose is used to generate ATP from ADP and inorganic phosphate (Pi). The chemical energy stored in ATP can be released by breaking it down to ADP and inorganic phosphate. This energy can be used for cellular activities including muscle cell contraction, cell division, protein synthesis and	Practical investigations on burning food. Practical investigations of DCPIP/Cabomba and hydrogen carbonate indicator. Use immobilised yeast and hydrogen carbonate indicator, resazurin or gas sensors and data loggers to investigate rate of respiration. Investigate respiration indirectly through breathing rates before and during exercise in humans.	Cells such as muscle, companion, sperm, neuron will have a high number of mitochondria as they require a lot of energy. Summary word equations for respiration:

Cell Biology		
key areas	**Suggested learning activities**	**Exemplification of key areas**
transmission of nerve impulses. ATP can be regenerated during respiration. The breakdown of each glucose molecule via pyruvate to carbon dioxide and water in the presence of oxygen yields 38 molecules of ATP. The breakdown of each glucose molecule via the fermentation pathway yields two molecules of ATP when oxygen is not present. Breakdown of glucose to lactic acid via pyruvate in animal cells. Breakdown of glucose to alcohol/ethanol and carbon dioxide via pyruvate in plant and yeast cells. c. Respiration begins in the cytoplasm. The process of fermentation is completed in the cytoplasm. Aerobic respiration starts in the cytoplasm and is completed in the mitochondria. d. Use of respirometers to measure rate of respiration.		Glucose + oxygen → carbon dioxide + water Glucose → ethanol/alcohol + carbon dioxide Glucose → lactic acid Links with Multicellular Organisms Unit.

Appendix 2: Unit assessment of Outcome 2: Revised content

The following guidance applies where a centre is delivering the revised course content from the National 5 Biology Course Specification version 2.0 (June 2017).

Centres can adapt the existing unit assessment support packs (UASPs) for Outcome 2 where candidates are being assessed for free-standing units.

Important note: This guidance is provided for the mechanism of Recognising Positive Achievement (RPA).

(a) Unit Assessment Support Pack 1 (Unit-by-Unit Approach)

Where a centre is using the assessments in UASP 1 these can be adapted as follows.

Cell Biology

- Remove Questions 3 and 7.

(b) Outcome 2, Assessment activity 2 - tests

Where a centre is using the Outcome 2, Assessment activity 2 tests, these can be adapted as follows.

Cell Biology

- Remove Questions 3, 4, 8 and 9.
- Insert an analysis type question.
  For example: Intermediate 2 Biology 2009, Section 1, Question 3 [1].
  One mark added to the total number of marks available to account for this question being used.
- Change ‘works best’ in question 6(d) to ‘is most active’.

Administrative information

Published: September 2018 (version 1.1)

Superclass: RH

History of changes to National Unit Specification

Version	Description of change	Authorised by	Date
1.1	Assessment standard threshold information added. Unit support notes added as Appendix 1. Guidance on assessment of Outcome 2 for RPA added as Appendix 2.	Qualifications Manager	September 2018