SCQF level 5
Unit Specification

Cell Biology

SCQF: level 5 (6 SCQF credit points)

Unit code: J4A9 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; DNA and the production of proteins; proteins; genetic engineering; 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 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*.

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; DNA and the production of proteins; proteins; genetic engineering; and respiration.

The following table describes the evidence for the Assessment Standards. Exemplification of assessment is provided in *Unit Assessment Support*.

Assessment Standard	Evidence required
Planning an experiment/practical investigation	The plan must 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
Following procedures safely	The learner must be seen to follow procedures safely.
Making and recording observations/measurements correctly	The raw data must be collated in a relevant format, for example a table.
Presenting results in an appropriate format	One format from: bar graph or line graph.
Drawing a valid conclusion	This must include reference to the aim and be supported by the results.
Evaluating experimental procedures	Provide one evaluative statement about the procedures used. **or** Suggest an improvement for the experiment. Appropriate justification must also be provided, whichever option is chosen.
Making accurate statements and solving problems	Achieve at least 50% of the total marks available in a holistic assessment. A holistic assessment must include: ♦ an appropriate number of opportunities to make accurate statements for each key area of the Unit ♦ at least one opportunity to demonstrate each of the following problem-solving skills: — make generalisations/predictions — select information — process information, including calculations, as appropriate — analyse information

Assessment Standard thresholds

Outcome 1

Learners 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. Learners must be given the opportunity to meet all Assessment Standards.

Outcome 2

Learners are assessed using a holistic assessment that assesses Assessment Standards 2.1 and 2.2. To gain a pass for Outcome 2, learners must achieve 50% or more of the total marks available in the assessment.

Transfer of evidence

Evidence for the achievement of Outcome 1 for this Unit can be used as evidence for the achievement of Outcome 1 in the SCQF level 5 Units: Biology: Life on Earth (J4AC 75) and Biology: Multicellular Organisms (J4AA 75).

Evidence for the achievement of Outcome 2 for this Unit is **not** transferable between the SCQF level 5 Units: Biology: Life on Earth (J4AC 75) and Biology: Multicellular Organisms (J4AA 75).

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 must be carried out under the same conditions as the original assessment.

Outcome 1

Learners can re-draft their original Outcome 1 report or carry out a new experiment/practical investigation.

Outcome 2

Learners must have a full re-assessment opportunity, ie a holistic assessment. To achieve Outcome 2, learners must achieve 50% of the total 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: 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:

- *Unit Assessment Support*

Developing skills, knowledge and understanding

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

Approaches to learning and teaching

Cell biology		
Key areas	**Depth of knowledge required**	**Suggested learning activities**
1 Cell structure		
a Cell ultrastructure and functions — cell wall, mitochondrion, chloroplast, cell membrane, cytoplasm, vacuole, nucleus, ribosome and plasmid using examples from typical plant, animal, fungal and bacterial cells.	Fungal structure in terms of similarity to plant and animal cells, but with a different cell wall structure. Structure of bacteria — absence of organelles and a different cell wall structure to plant and fungal cells.	♦ Examine slides of a range of plant, animal and microbial cells using a light microscope/bioviewer, for example onion/rhubarb epidermis, cheek epithelium, yeast and prepared slides of bacterial cells.
b Cell wall is made of cellulose in plant cells, but of different materials in fungal and bacterial cells.	Chemical composition of cell walls for fungi and bacteria not required.	♦ Numeracy activities on cell size to investigate cell length and breadth.

Cell biology		
Key areas	**Depth of knowledge required**	**Suggested learning activities**
2 Transport across cell membranes		
a The cell membrane consists of phospholipids and proteins and is selectively permeable.		♦ Investigate the structure of the fluid mosaic model, for example examine electron micrographs of cell membranes or make models. ♦ Investigate the effect of ethanol and temperature on cells, for example beetroot.
b Passive transport occurs down a concentration gradient and does not require energy. Examples of passive transport are diffusion and osmosis.	Different concentrations of substances exist between cells and their environment.	
c Diffusion is the movement of molecules down a concentration gradient from a higher to a lower concentration.	Explain diffusion of important substances, such as glucose, carbon dioxide and oxygen in terms of their concentration gradients.	♦ Investigate diffusion and osmosis using Visking tubing, osmosis in potato cells, bleeding in plant cells (for example beetroot), plant cell plasmolysis, mass changes in egg (shell removed by soaking in vinegar) in syrup and/or water.
d Osmosis is the movement of water molecules from a higher water concentration to a lower water concentration through a selectively permeable membrane.		

Cell biology		
Key areas	**Depth of knowledge required**	**Suggested learning activities**
2 Transport across cell membranes (continued) e Animal cells can burst or shrink and plant cells can become turgid or plasmolysed. Relationship between different concentrations of solutions and their effect on cells.	Details of the terms hypotonic, hypertonic and isotonic are not required.	
f Active transport requires energy for membrane proteins to move molecules and ions against the concentration gradient.	Details of how active transport takes place are not required.	♦ Research appropriate examples for active transport, for example sodium and potassium in nerve cells, or iodine in seaweeds.
3 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 proteins. A gene is a section of DNA that codes for a protein.		♦ Research the relationship between chromosomes, genes, DNA and protein to illustrate that genes are located on chromosomes. ♦ Construct 2D or 3D DNA models, or paper models of base pairing or DNA sections. ♦ Carry out numeracy activities to determine base pair numbers from given information.
b Messenger RNA (mRNA) is a molecule that carries a complementary copy of the genetic code from the DNA, in the nucleus, to a ribosome, where the protein is assembled from amino acids.	Knowledge of uracil as a base in mRNA is not required. Further details of transcription and translation are not required.	

Cell biology		
Key areas	**Depth of knowledge required**	**Suggested learning activities**
4 Proteins a The variety of protein shapes and functions arises from the sequence of amino acids. Proteins have many functions, such as structural, enzymes, hormones, antibodies and receptors.	Levels of protein structure, such as secondary or tertiary not required.	
b 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).	An enzyme-substrate complex forms, facilitating the reaction. Diagrams to illustrate the stages in degradation and synthesis reactions. Substrate $\xrightarrow{\text{Enzyme}}$ Product	♦ Experiments to investigate the specificity of enzymes. ♦ Investigate the action of potato phosphorylase.
c Each enzyme is most active in its optimum conditions. Enzymes, and other proteins, can be affected by temperature and pH. Enzymes can be denatured, resulting in a change in their shape, which will affect the rate of reaction.		♦ Enzyme experiments with, for example pepsin/lipase/amylase/catalase to investigate the effect of temperature and/or pH on activity. ♦ Effect of temperature and pH on egg white as a model for effect on proteins.

Cell biology		
Key areas	**Depth of knowledge required**	**Suggested learning activities**
5 Genetic engineering Genetic information can be transferred from one cell to another by genetic engineering. Stages of genetic engineering: identify section of DNA that contains required gene from source chromosome; extract required gene; extract plasmid from bacterial cell; insert required gene into bacterial plasmid; insert plasmid into host bacterial cell to produce a genetically modified (GM) organism. Use of enzymes in this process.	Names of particular enzymes are not required.	♦ Research current genetic foods or issues, such as golden rice, less-toxic rapeseed oil, bird resistance to bird flu, tomatoes with longer shelf life, blight-resistant potatoes, production of medicines for human use, for example insulin and growth hormone.
6 Respiration a The chemical energy stored in glucose must be released by all cells through a series of enzyme-controlled reactions called respiration.		♦ Burning food to show energy release. ♦ Using a hydrogen carbonate indicator to show respiration in living organisms.
b The energy released from the breakdown of glucose is used to generate ATP. The energy transferred by ATP can be used for cellular activities, such as muscle cell contraction, cell division, protein synthesis and transmission of nerve impulses.	How ATP is generated is not required. Examples of energy uses given are not exhaustive.	♦ Using simple respirometers to measure rate of respiration in, for example small invertebrates or germinating peas. ♦ Using immobilised yeast and hydrogen carbonate indicator, resazurin or gas sensors and data loggers to investigate rate of respiration.

Cell biology		
Key areas	**Depth of knowledge required**	**Suggested learning activities**
6 Respiration (continued) c Glucose is broken down to two molecules of pyruvate, releasing enough energy to yield two molecules of ATP. Further breakdown depends on the presence or absence of oxygen. If oxygen is present, aerobic respiration takes place, and each pyruvate is broken down to carbon dioxide and water, releasing enough energy to yield a large number of ATP molecules. In the absence of oxygen, the fermentation pathway takes place. In animal cells, the pyruvate molecules are converted to lactate and in plant and yeast cells they are converted to carbon dioxide and ethanol. The breakdown of each glucose molecule via the fermentation pathway yields only the initial two molecules of ATP. d Respiration begins in the cytoplasm. The process of fermentation is completed in the cytoplasm; whereas aerobic respiration is completed in the mitochondria.	Overall number of ATP molecules generated by aerobic respiration not required. Word summaries of the process of respiration: Glucose + oxygen $\rightarrow$ carbon dioxide + water + energy Glucose $\rightarrow$ carbon dioxide + ethanol + energy Glucose $\rightarrow$ lactate + energy The higher the energy requirement of a cell, the greater the number of mitochondria present in that cell.	

Administrative information

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History of changes to National Unit Specification

Version	Description of change	Authorised by	Date