National Unit specification

General information

Unit title: Introductory Biology (SCQF level 5)

Unit code: HT8P 45

Superclass: RH

Publication date: August 2017

Source: Scottish Qualifications Authority

Version: 01

Unit purpose

This unit is designed to provide learners with an introduction to key biological principles, and to provide a background in biology for those who have no previous knowledge or experience in the subject. The unit is suitable for learners studying at NC level, and will provide the necessary underpinning knowledge and skills to enable progression to further study of biology at Higher level.

Outcomes

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

1 Describe the structure and function of living cells.
2 Describe cellular biochemical processes: enzyme activity, respiration and photosynthesis.
3 Describe the structure and function of the digestive and cardiovascular systems.
4 Describe the evolution of life on earth.

Credit points and level

1 National Unit credit at SCQF level 5: (6 SCQF credit points at SCQF level 5)

Recommended entry to the unit

Entry is at the discretion of the centre.

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.

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**.

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.

Outcome 1

Describe the structure and function of living cells.

Performance criteria

(a) Describes the structure and function of animal cells.
(b) Describes the structure and function of plant cells.
(c) Describes the structure and function of microbial cells
(d) Describes diffusion and osmosis in relation to their effects on plant and animal cells.
(e) Describes the structure and function of proteins and nucleic acids.

Outcome 2

Describe cellular biochemical processes: enzyme activity, respiration and photosynthesis.

Performance criteria

(a) Explains enzyme action in terms of enzyme properties and factors affecting activity.
(b) Compares aerobic respiration and the fermentation pathway in terms of energy release and products.
(c) Describes photosynthesis in terms of energy fixation and factors affecting rate.

Outcome 3

Describe the structure and function of the digestive and cardiovascular systems.

Performance criteria

(a) Describes mammalian nutrition in terms of food breakdown and the structure and function of the alimentary canal and associated organs.
(b) Describes cardiovascular system in terms of structure and function of heart, blood vessels and lungs.

Outcome 4

Describe the evolution of life on earth.

Performance criteria

(a) Explains biodiversity and adaption to environmental niches.
(b) Describes the process of natural selection and evolution of species.

National Unit specification: Statement of standards (cont)

Unit title: Introductory Biology (SCQF level 5)

Evidence requirements for this unit

Evidence is required to demonstrate that learners have achieved all outcomes and performance criteria.

Written and/or oral recorded evidence for Outcomes 1 to 4 should be assessed using a holistic closed-book assessment under supervised conditions. It is recommended that the assessment be completed within 45 minutes.

National Unit Support Notes

Unit title: Introductory Biology (SCQF level 5)

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 the NC Applied Sciences Group Awards but may be suitable for inclusion in other science awards. It is designed to provide learners with an introduction to cell structure, cellular biochemistry, organ systems and evolution. It is envisioned that this unit will provide knowledge and understanding in biological principles to learners undertaking the physical applied sciences route.

Outcome 1 — Describe the structure and function of living cells

In this outcome learners will be introduced to similarities and differences between animal, plant and microbial cell structures, in addition to the function of cellular structures and how this structure relates to function. The process of diffusion as the movement of substances from a high concentration to a low concentration will also be introduced. The semi-permeable nature of the cell membrane should be covered, progressing to the process of osmosis and its effects on both plant and animal cells. The structure and function of DNA and RNA should be discussed in terms of protein synthesis. The nature of DNA as the hereditary information, double helix structure, complementary base pairing and the concept of genes should be discussed, leading on to nature as RNA as a messenger molecule used in protein synthesis. The structure of proteins as fibrous or globular molecules could be introduced to follow on to enzymes in Outcome 2. Transcription and translation could also be introduced but does not need to be covered in terms of the detail of these processes in the cell.

Outcome 2 — Describe cellular biochemical processes: enzyme activity, respiration and photosynthesis

In this outcome learners will be introduced to enzymes as biological catalysts, enzyme specificity and common enzyme catalysed reactions. This should cover both synthesis and degradation reactions, linking into Outcome 3 and the digestive system. Covering the principles of enzyme action, the enzyme catalysed reactions of respiration and photosynthesis should be discussed. The concept of respiration as a two part energy generating reaction; substrate (glycolysis) and oxidative (Krebs cycle and cytochrome system) phosphorylation. Both aerobic respiration and the fermentation pathway should be compared in terms of energy release, yield of ATP and final products of the reactions. The concept of photosynthesis as a two-part energy fixation reaction; photolysis followed by carbon fixation should be covered. Additional factors that affect the rate of photosynthesis, limiting factors and the relationship to horticulture should also be introduced.

National Unit Support Notes (cont)

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Outcome 3 — Describe the structure and function of the digestive and cardiovascular systems

In this outcome the organ systems in animal physiology should be discussed to provide learners with an overview of the main systems; cardiovascular, respiratory, renal and digestive. Two mammalian organ systems should be described in detail — the digestive and cardiovascular systems — in terms of structure and function. Learners should be introduced to the requirement for and energy content of food. The breakdown reactions of the three main components of food should be detailed along with the need for digestion. The anatomy and role of the alimentary canal, oesophagus, stomach, small and large intestine and rectum in the breakdown and absorption of food should be covered, alongside the role of the associated organs, salivary glands, pancreas, liver and gall bladder. The structure and function of the heart, lungs and capillary network in gas exchange should also be covered. Learners should be introduced to the anatomy of the heart, blood vessels and lungs and the features that are important for their function in the circulatory system. The capillary network and its role in gas exchange in tissues should also be covered.

Outcome 4 — Describe the evolution of life on earth

In this outcome learners will be introduced to the concepts of biodiversity and diversity of environmental habitats and niches. This should cover adaptation of organisms to habitats and niches and the process of natural selection. Selective breeding and genetic engineering should also be covered, along with speciation and mechanisms that drive speciation.

Guidance on approaches to delivery of this unit

It is recommended that the outcomes are delivered in numerical order. While there are no assessed practical activities in this unit, it is envisaged that laboratory practicals will play a large part in delivery.

Outcome 1 could commence with an overview of cells as the basic unit of life. The similarities and differences in animal, plant and microbial cells could be illustrated with the use of both light and electron microscopy images and cartoons, supported by examination of prepared microscope slides by light microscopy. Learners could also prepare microscope slides of plant, animal and microbial material for examination by light microscopy. Diffusion could be explained through examples of substances which enter and leave the cell by diffusion, eg glucose and amino acids (dissolved food), oxygen, carbon dioxide and waste products, eg urea. Osmosis can be defined as the movement of water across a selectively permeable membrane as a result of a water concentration gradient and could be illustrated by the use of real world examples, eg turgor in plant cells. The biomolecules of the cell, DNA, RNA and proteins should be discussed in terms of the central dogma of molecular biology. The terms transcription and translation could be introduced but need not be covered in terms of the detail of these process in the cell. The structure of these molecules could be illustrated with molecular models to enable learners to visualise these molecules. The use of laboratory practical experiments would support the learning of this concept. Demonstration of osmosis could be achieved using model cells or pieces of potato placed in solutions of varying osmolarity.

National Unit Support Notes (cont)

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Outcome 2 could commence with an introduction to enzymes as biological catalysts made by all living cells and essential for the functioning of all living cells. The properties and functions of catalysts (lower the energy input required for chemical reactions; speed up chemical reactions; take part in reactions but remain unchanged) should be described. Enzymes being proteins with unique conformations determining specificity could be illustrated by the use of 3D X-ray crystal structures of proteins and ligands. Respiration and photosynthesis could then be introduced as a series of enzyme controlled reactions. Respiration is the means by which chemical energy stored in glucose is released. Some of this energy is lost as heat from cells but most is used to generate ATP, the energy currency of the cell used for cellular activities such as muscle contraction. The pathways and products of aerobic respiration and fermentation could then be covered and the yield of ATP from the two pathways compared. The idea of 'oxygen debt' could be discussed to illustrate to learners the differences in fermentation pathways of animals, plants and microbes. Photosynthesis could then be introduced as the process of converting light energy from the sun into chemical energy in the form of ATP, which is used for synthesis of glucose in plants and some microbes. Photosynthesis could be presented as a two part process; photolysis, the splitting of water molecules by light absorbed by chlorophyll and producing oxygen as a by-product and carbon fixation occurring in the stroma of chloroplast in which glucose is synthesised from carbon dioxide and the hydrogen generated during photolysis. The movement of carbon dioxide and oxygen into and out of the leaf could be used to link to diffusion, which was covered in Outcome 1. Factors that limit the rate of photosynthesis could then be covered by the use of real world horticulture examples, eg heat and light and carbon dioxide supplementation to increase yield or produce early crops.

Outcome 3 could commence with an overview of how cells combine to produce the tissues which make up organs and the organ system of an organism. The major mammalian organ systems should be outlined and the use of models would be valuable in providing learners with a realistic view of the mammalian anatomy. The main food groups (carbohydrates, proteins, fats, vitamins and minerals) and their roles in the body should be introduced. Following on from this, the elemental composition and breakdown products of carbohydrates, fats and proteins could be covered along with examples of enzymes which catalyse these reactions, linking back to Outcome 2. The importance of food and the energy content of the main components of food could then be discussed. Digestion should be described as the breakdown of large, insoluble food molecules into smaller, soluble food molecules to allow absorption into the blood stream through the lining of the small intestine. The mechanical breakdown of food begins in the mouth. Saliva contains amylase which digests starch into maltose. Mucus in saliva from salivary glands helps to lubricate the mouth and food to aid swallowing. Oesophagus and the mechanism of peristalsis could then be covered. It should be noted that peristalsis occurs throughout the length of the alimentary canal and not just in the oesophagus. Details of the teeth are not required. The role of the stomach in the mechanical and chemical breakdown of proteins could then be covered progressing on to the breakdown of fats in the small intestine by lipase produced by the pancreas, which follows emulsification of fats by bile produced by the liver and stored in the gall bladder. The features of the small intestine which make it suitable for the absorption of materials (villi, microvilli, capillary network) could then be covered and the destinations of the absorbed molecules highlighted: glucose and amino acids carried to the liver via the blood, fats absorbed into the lacteal. The role of the large intestine in water absorption and the rectum and anus in expulsion of waste complete the transit of food through the digestion system.

National Unit Support Notes (cont)

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There are many videos available of both the digestive system via colonoscopy footage and dissections of animal digestive systems. These provide real life views of the digestive system and allow learners to familiarise themselves with the pathway of food transit though the body.

Respiration from Outcome 2 and digestion from Outcome 3 could be used to introduce the need for the cardiovascular system. The need for oxygen as a requirement for aerobic respiration and the need to expel carbon dioxide as well as transport nutrients around the body. These points provide the context for the study of the cardiovascular system. The concept of diffusion from Outcome 1 could be integrated in the principle of gas exchange in the lung. The structures of the cardiovascular system (heart, blood vessels, trachea, bronchi, bronchioles, alveoli, overall anatomy of the lungs) could be covered before focusing on the features of the heart as a muscular pump, the function of the arteries, veins and capillaries and gas exchange at the alveoli and the adaptations present that ensure efficient gas exchange. Opportunities for dissection of animal heart and lung tissue would be a useful learning opportunity where available.

Outcome 4 could commence with the introduction of the concept of biodiversity, defined as the range of species in an ecosystem. A species is defined as a group of organisms which can interbreed to produce fertile offspring. Within an ecosystem there are a range of habitats and niches which provide the range of materials required by a species for survival; food, shelter, light, water, etc. Learners could then be introduced to the concept of variation within species and the principle that the final appearance of an organism (phenotype) is the result of its genotype and the effects of the environment. If organisms of identical genotype are subject to different environmental conditions they show considerable variation. Learners could then cover natural selection; the process by which organisms better adapted to their environment to survive and breed, while those less well adapted fail to do so. The better adapted organisms are more likely to pass their characteristics to succeeding generations. Natural selection can be illustrated by suitable examples, eg the peppered moth. This leads on to the concept of speciation, the process whereby isolated populations become increasingly dissimilar over time as they are acted on by natural selection in their different habitats. When they are no longer able to interbreed and produce fertile offspring, they have become separate species.

Outcome 4 provides excellent material for learners to undertake literature projects investigating the impact of human activity on biodiversity and natural selection. There is also the opportunity to engage learners with discussion and debate as to whether human beings as a species have advanced sufficiently to evade evolutionary forces.

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 requirements as detailed in the performance criteria. Assessment should be carried out in supervised conditions, and it is recommended that the assessment be completed within 45 minutes.

An exemplar instrument of assessment with marking guidelines has been produced to indicate the national standard of achievement at SCQF level 5.

National Unit Support Notes (cont)

Unit title: Introductory Biology (SCQF level 5)

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

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

Numeracy — Using Graphical Information at SCQF level 4

Learners may be required to use graphical methods to present or interpret data on composition of common foodstuff or numbers of species in a range of habitats.

Working with Others — Working Co-operatively with Others at SCQF level 4

Learners may undertake team work in laboratory activities where tasks must be planned and work carried out cooperatively to achieve end outcomes. Learners may also have the opportunity to carry out group based research projects, presenting results as a presentation or poster.

Information and Communication Technology — Accessing Information and Providing/Creating Information at SCQF level 4

Learners may be required to use online resources to research factors affecting biodiversity and choose a suitable medium to present the findings.

Sustainability

Sustainability may be embedded in the delivery of this unit in a variety of ways. For example, by encouraging minimum usage, correct disposal procedures and possibly recycling (eg of solvents) during practical experiments. Sustainability may also be emphasised and discussed when investigating the effects of human activity on biodiversity.

History of changes to unit

Version	Description of change	Date

General information for learners

Unit title: Introductory Biology (SCQF level 5)

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 5, which you are likely to be studying as part of a NC Applied Sciences programme. This unit is designed to provide you with an introduction to cell structure, cellular biochemistry, organ systems and evolution.

On completion of the unit you should be able to:

1 Describe the structure and function of living cells.
2 Describe cellular biochemical processes: enzyme activity, respiration and photosynthesis.
3 Describe the structure and function of the digestive and cardiovascular systems.
4 Describe the evolution of life on earth.

Outcome 1

In this outcome you will learn about the structure and function of animal, plant and microbial cells. You will also learn about the processes of diffusion and osmosis and the impacts these processes have on living cells. Furthermore, you will also learn about the structure and function of proteins and nucleic acids.

Outcome 2

In this outcome you will learn about the processes by which different cells obtain energy for their activities. You will be introduced to the concept of respiration as the process by which cells obtain energy from food sources and photosynthesis as the process plants use to obtain energy from sunlight. You will also learn about the chemical reactions that require energy in the cell and discover the features of enzymes that enable them to catalyse these reactions.

Outcome 3

In this outcome you will learn about the role of the digestive and cardiovascular systems in animal physiology. You will develop your knowledge of enzymes from Outcome 2 by investigating the role of enzymes in the digestive process. You will also learn about the structure of the digestive system and the key organs in the digestive process. You will be introduced to the structure of the heart, lungs and circulatory systems and how these relate to their function. Furthermore you will learn about the role of the circulatory system in the distribution of materials to all of the cells of the body.

Outcome 4

In this outcome you will learn about the concept of biodiversity within ecosystems. You will investigate the range of species that live within habitats and how that relates to the resources provided by different habitats. You will also learn about the concept of natural selection and evolution of species.

General information for learners (cont)

Unit title: Introductory Biology (SCQF level 5)

Assessment

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

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*, *Working with Others* and *Information and Communication Technology (ICT)* at SCQF level 4.