National 5 Course Specification

# National 5 Biology

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| **Course code:** | C807 75 |
| **Course assessment code:** | X807 75 |
| **SCQF:** | level 5 (24 SCQF credit points) |
| **Valid from:** | session 2022–23 |

The course specification provides detailed information about the course and course assessment to ensure consistent and transparent assessment year on year. It describes the structure of the course and the course assessment in terms of the skills, knowledge and understanding that are assessed.

This document is for teachers and lecturers and contains all the mandatory information you need to deliver the course.

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# Contents

# Course overview

The course consists of 24 SCQF credit points which includes time for preparation for course assessment. The notional length of time for a candidate to complete the course is 160 hours.

The course assessment has two components.

| Component | Marks | Scaled mark | Duration |
|---|---|---|---|
| Component 1: question paper | 100 | n/a | 2 hours and 30 minutes |
| Component 2: assignment | 20 | 25 | 8 hours of which a maximum of 1 hour and 30 minutes is allowed for the report stage — see course assessment section |

| Recommended entry | Progression |
|---|---|
| Entry to this course is at the discretion of the centre.<br><br>Candidates should have achieved the fourth curriculum level or the National 4 Biology course or equivalent qualifications and/or experience prior to starting this course.<br><br>Candidates may also progress from relevant chemistry, environmental science, physics or science courses. | ♦ other qualifications in biology/human biology or related areas<br>♦ further study, employment or training |

## Conditions of award

The grade awarded is based on the total marks achieved across all course assessment components.

# Course rationale

National Courses reflect Curriculum for Excellence values, purposes and principles. They offer flexibility, provide more time for learning, more focus on skills and applying learning, and scope for personalisation and choice.

Every course provides opportunities for candidates to develop breadth, challenge and application. The focus and balance of assessment is tailored to each subject area.

Biology, the study of living organisms, plays a crucial role in our everyday existence and is an increasingly important subject in the modern world. Biology affects everyone and aims to find solutions to many of the world's problems. Advances in technologies have made this varied subject more exciting and relevant than ever.

Biology courses should encourage development of skills and resourcefulness which lead to becoming a confident individual. Successful candidates in biology think creatively, analyse and solve problems. Studying relevant areas of biology such as health, environment and sustainability produces responsible citizens.

The National 5 Biology course allows candidates to understand and investigate the living world in an engaging and enjoyable way. It develops candidates' abilities to think analytically, creatively and independently, and to make reasoned evaluations. The course provides opportunities for candidates to acquire and apply knowledge to evaluate biological issues, assess risk, make informed decisions and develop an ethical view of complex issues. Candidates are able to develop their communication, collaborative working and leadership skills, and are able to apply critical thinking in new and unfamiliar contexts to solve problems.

# Purpose and aims

The purpose of the National 5 Biology course is to develop candidates' interest and enthusiasm for biology in a range of contexts. The skills of scientific inquiry and investigation are developed, throughout the course, by investigating the applications of biology. This enables candidates to become scientifically literate citizens, able to review the science-based claims they meet.

The course will be of interest and value to candidates wishing to develop skills, knowledge and understanding of biology. The course is a broad and up-to-date selection of concepts and ideas relevant to the central position of life science within our society. An experimental and investigative approach is used to develop knowledge and understanding of key areas of biology.

The course covers major areas of biology ranging from cellular to whole organism and includes the study of ecosystems. The focus on cellular level processes leads to an understanding of the importance and roles of the cell. By comparing the processes in multicellular plants and animals, candidates investigate increasing levels of complexity. The key areas of biodiversity and interdependence are covered, along with the processes leading to evolution as well as food security and ethical issues.

The course allows flexibility and personalisation by offering choice in the contexts studied.

The aims of the course are for candidates to:

- develop and apply knowledge and understanding of biology
- develop an understanding of the impact of biology on everyday life
- develop an understanding of biology's role in scientific issues and relevant applications of biology, including the impact these could make on society and the environment
- develop scientific inquiry and investigative skills
- develop scientific analytical thinking skills in a biology context
- develop the skills to use technology, equipment and materials, safely, in practical scientific activities
- develop planning skills
- develop problem-solving skills in a biology context
- use and understand scientific literacy, in everyday contexts, to communicate ideas and issues and to make scientifically informed choices
- develop the knowledge and skills for more advanced learning in biology
- develop skills of independent working

The course also aims to equip all candidates with the knowledge and skills to be able to evaluate media reports. This enables candidates to make their own decisions on issues within a modern society where the body of scientific knowledge and its applications and implications are ever developing.

# Who is this course for?

The course is suitable for learners who have experienced learning across the sciences experiences and outcomes. The course may be suitable for those wishing to study biology for the first time.

This course has a skills-based approach to learning. It takes account of the needs of all learners and provides sufficient flexibility to enable learners to achieve in different ways.

# Course content

Candidates develop skills of scientific inquiry, and analytical thinking, along with knowledge and understanding. These skills, knowledge and understanding of biology are developed through a variety of approaches and in the context of each of the three main areas of the course. Candidates undertake practical activities in the classroom/local environment. Candidates research issues and communicate information related to their findings, which develops skills of scientific literacy.

The course content includes the following areas of biology:

**Cell biology**
The key areas covered are: cell structure; transport across cell membranes; DNA and the production of proteins; proteins; genetic engineering; respiration.

**Biology: multicellular organisms**
The key areas covered are: producing new cells; control and communication; reproduction; variation and inheritance; transport systems — plants; transport systems — animals; absorption of materials.

**Biology: life on Earth**
The key areas covered are: ecosystems; distribution of organisms; photosynthesis; energy in ecosystems; food production; evolution of species.

# Skills, knowledge and understanding

## Skills, knowledge and understanding for the course

The following provides a broad overview of the subject skills, knowledge and understanding developed in the course:

- demonstrating knowledge and understanding of biology by making statements, describing information, providing explanations and integrating knowledge
- applying knowledge of biology to new situations, interpreting information and solving problems
- planning, designing and safely carrying out experimental/fieldwork investigations to test given hypotheses or to illustrate particular effects
- selecting information from a variety of sources
- presenting information appropriately in a variety of forms
- processing information (using calculations and units, where appropriate)
- making predictions and generalisations based on evidence/information
- drawing valid conclusions and giving explanations supported by evidence/justification
- suggesting improvements to experimental/fieldwork investigations
- communicating findings/information

## Skills, knowledge and understanding for the course assessment

The following provides details of skills, knowledge and understanding sampled in the course assessment.

The course support notes provide further detail on the depth of knowledge required for each key area of the course.

**Note:** The key areas of the course and apparatus and techniques noted below **and** the depth of knowledge required for each key area noted in the course support notes **can be assessed in the question paper**.

| **Cell biology** |
|---|
| **1 Cell structure**<br><br>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.<br>b Cell wall is made of cellulose in plant cells but of different materials in fungal and bacterial cells. |
| **2 Transport across cell membranes**<br><br>a The cell membrane consists of phospholipids and proteins and is selectively permeable.<br>b Passive transport occurs down a concentration gradient and does not require energy. Examples of passive transport are diffusion and osmosis.<br>c Diffusion is the movement of molecules down a concentration gradient from a higher to a lower concentration.<br>d Osmosis is the movement of water molecules from a higher water concentration to a lower water concentration through a selectively permeable membrane.<br>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.<br>f Active transport requires energy for membrane proteins to move molecules and ions against the concentration gradient. |
| **3 DNA and the production of proteins**<br><br>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 which codes for a protein.<br>b Messenger RNA (mRNA) is a molecule which 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. |

## Cell biology

### 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.

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).

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.

### 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.

### 6 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. 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.

c Glucose is broken down to two molecules of pyruvate, releasing enough energy to yield two molecules of ATP. Further breakdown depends upon the presence/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.

## Biology: multicellular organisms

### 1 Producing new cells

a Sequence of events of mitosis. Understanding of the terms chromatids, equator and spindle fibres.

b Mitosis provides new cells for growth, repair of damaged tissues and replacement of dead or damaged cells. It also maintains the diploid chromosome complement.

c Stem cells in animals are unspecialised cells which can divide in order to self-renew. They have the potential to become different types of cell. Stem cells are involved in growth and repair.

d Specialisation of cells leads to the formation of a variety of cells, tissues and organs. Groups of organs which work together form systems.
A hierarchy exists: cells → tissues → organs → systems.

### 2 Control and communication

a **Nervous control**

i Nervous system consists of central nervous system (CNS) and other nerves. CNS consists of brain and spinal cord. Structure and function of parts of the brain — cerebrum, cerebellum and medulla. Neurons are of three types: sensory, inter and motor. Receptors detect sensory input/stimuli. Electrical impulses carry messages along neurons. Chemicals transfer these messages between neurons, at synapses.

ii Structure and function of reflex arc.

b **Hormonal control**

i Endocrine glands release hormones into the bloodstream. Hormones are chemical messengers. A target tissue has cells with complementary receptor proteins for specific hormones, so only that tissue will be affected by these hormones.

ii Blood glucose regulation. The roles of insulin, glucagon, glycogen, pancreas and liver.

### 3 Reproduction

a Cells are diploid, except gametes, which are haploid.

b The types of gametes, the organs that produce them and where these are located in plants and animals. The basic structure of sperm and egg cells.

c Fertilisation is the fusion of the nuclei of the two haploid gametes to produce a diploid zygote, which divides to form an embryo.

## Biology: multicellular organisms

### 4 Variation and inheritance

a Comparison of discrete variation (single gene inheritance) and continuous variation (polygenic inheritance).
b Understanding of genetic terms: gene; allele; phenotype; genotype; dominant; recessive; homozygous; heterozygous and P, $F_1$ and $F_2$.
c Monohybrid crosses from parental generation through to $F_2$ generation.
d Reasons why predicted phenotype ratios among offspring are not always achieved.

### 5 Transport systems — plants

a Plant organs are roots, stems and leaves. Leaf structure diagram showing upper epidermis, palisade mesophyll, spongy mesophyll, vein (consisting of xylem and phloem), lower epidermis, guard cells and stomata.
b Parts of the plant involved in water transport. Water and minerals enter the plant through the root hairs and are transported in dead xylem vessels.
Structure of xylem vessels.
c The process of transpiration and how the rate of transpiration is affected by wind speed, humidity, temperature and surface area.
d Sugar is transported up and down the plant in living phloem.
Structure of phloem tissue.

### 6 Transport systems — animals

a In mammals the blood contains plasma, red blood cells and white blood cells. It transports nutrients, oxygen and carbon dioxide.
b Red blood cells are specialised by being biconcave in shape, having no nucleus and containing haemoglobin. This allows them to transport oxygen efficiently in the form of oxyhaemoglobin.
c White blood cells are part of the immune system and are involved in destroying pathogens. There are two main types of cells involved. Phagocytes carry out phagocytosis by engulfing pathogens. Some lymphocytes produce antibodies which destroy pathogens. Each antibody is specific to a particular pathogen.
d Pathway of oxygenated and deoxygenated blood through heart, lungs and body. Diagram of heart to show the right and left atria, ventricles, location of four valves, location of associated blood vessels (aorta, vena cava, pulmonary artery, pulmonary vein and coronary arteries). Function of each of these parts.
e Arteries have thick, muscular walls, a narrow central channel and carry blood under high pressure away from the heart. Veins have thinner walls, a wider channel and carry blood under low pressure back towards the heart. Veins contain valves to prevent backflow of blood. Capillaries are thin walled and have a large surface area, forming networks at tissues and organs to allow efficient exchange of materials.

**Biology: multicellular organisms**

**7 Absorption of materials**

a Oxygen and nutrients from food must be absorbed into the bloodstream to be delivered to cells for respiration. Waste materials, such as carbon dioxide, must be removed from cells into the bloodstream.

b Tissues contain capillary networks to allow the exchange of materials at cellular level.

c Surfaces involved in the absorption of materials have certain features in common: large surface area, thin walls, extensive blood supply. These increase the efficiency of absorption.

d Lungs are gas exchange organs. They consist of a large number of alveoli providing a large surface area. Oxygen and carbon dioxide are absorbed through the thin alveolar walls to or from the many blood capillaries.

e Nutrients from food are absorbed into the villi in the small intestine. The large number of thin walled villi provides a large surface area. Each villus contains a network of capillaries to absorb glucose and amino acids and a lacteal to absorb fatty acids and glycerol.

## Biology: life on Earth

### 1 Ecosystems

a Definitions of ecological terms: species, biodiversity, population, producer, consumer, herbivore, carnivore, omnivore, predator, prey, food chain, food web.
b An ecosystem consists of all the organisms (the community) living in a particular habitat and the non-living components with which the organisms interact. Interactions of organisms in food webs.
c A niche is the role that an organism plays within a community. It relates to the resources it requires in its ecosystem, such as light and nutrient availability and its interactions with other organisms in the community. It involves competition and predation and the conditions it can tolerate such as temperature.
d Competition in ecosystems occurs when resources are in short supply. Interspecific competition occurs amongst individuals of different species for one or a few of the resources they require. Intraspecific competition occurs amongst individuals of the same species and is for all resources required. Intraspecific competition is therefore more intense than interspecific competition.

### 2 Distribution of organisms

a Competition for resources, disease, food availability, grazing and predation are biotic factors. Light intensity, moisture, pH and temperature are abiotic factors.
b Measuring abiotic factors such as light intensity, soil moisture, pH and temperature. Possible sources of error and how to minimise them.
c Sampling of plants and animals using quadrats and pitfall traps. Evaluation of limitations and sources of error in their use.
d Using and constructing paired-statement keys to identify organisms.
e The effect of biotic and abiotic factors on biodiversity and the distribution of organisms.
f Indicator species are species that by their presence or absence indicate environmental quality/levels of pollution.

### 3 Photosynthesis

a Photosynthesis is a two-stage process:
  i Light reactions: the light energy from the sun is trapped by chlorophyll in the chloroplasts and is converted into chemical energy which is used to generate ATP. Water is split to produce hydrogen and oxygen. Oxygen diffuses from the cell.
  ii 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 the sugar 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.

**Biology: life on Earth**

**4 Energy in ecosystems**

a In transfers from one level to the next in a food chain, the majority of the energy is lost as heat, movement or undigested materials. Only a very small quantity is used for growth and is therefore available at the next level in a food chain.
b Definitions and comparisons of pyramids of numbers and energy.

**5 Food production**

a Increasing human population requires an increased food yield. This can involve the use of fertilisers and pesticides. Fertilisers provide chemicals such as nitrates which increase crop yield. Plants and animals which reduce crop yield can be killed by pesticides.
b Nitrates dissolved in soil water are absorbed into plants. Nitrates are used to produce amino acids which are synthesised into plant proteins. Animals consume plants or other animals to obtain amino acids for protein synthesis. Fertilisers can be added to soil to increase the nitrate content of the soil.
c Fertilisers can leach into fresh water, adding extra, unwanted nitrates. This will increase algal populations which can cause algal blooms. Algal blooms reduce light levels, killing aquatic plants. These dead plants, as well as dead algae, become food for bacteria which increase greatly in number. The bacteria use up large quantities of oxygen, reducing the oxygen availability for other organisms.
Genetically modified (GM) crops can be used to reduce the use of fertilisers.
d Pesticides sprayed onto crops can accumulate in the bodies of organisms over time. As they are passed along food chains, toxicity increases and can reach lethal levels.
The use of biological control and genetically modified (GM) crops as alternatives to the use of pesticides.

**6 Evolution of species**

a A mutation is a random change to genetic material. Mutations may be neutral, confer an advantage or a disadvantage to survival.
Mutations are spontaneous and are the only source of new alleles.
Environmental factors, such as radiation and some chemicals, can increase the rate of mutation.
b New alleles produced by mutation can result in plants and animals becoming better adapted to their environment. Variation within a population makes it possible for a population to evolve over time in response to changing environmental conditions.
c Species produce more offspring than the environment can sustain. Natural selection or survival of the fittest occurs when there are selection pressures. The best adapted individuals in a population survive to reproduce, passing on the favourable alleles that confer the selective advantage. These alleles increase in frequency within the population.
d Speciation occurs after part of a population becomes isolated by an isolation barrier, which can be geographical, ecological or behavioural. Different mutations occur in each sub-population. Natural selection selects for different mutations in each group, due to different selection pressures. Each sub-population evolves until they become so genetically different that they are two different species.

**Apparatus and techniques**

In addition to the key areas, candidates must have knowledge of the following pieces of apparatus and have opportunities to become familiar with the following techniques.

**Apparatus**

- beaker
- balance
- measuring cylinder
- dropper/pipette
- test tube/boiling tube
- thermometer
- funnel
- syringe
- timer/stopwatch
- microscope
- petri dish
- quadrat
- pitfall trap
- light/moisture meter
- water bath

**Techniques**

- measuring enzyme activity
- using a respirometer
- measuring transpiration using a potometer
- measuring abiotic factors
- measuring the distribution of a species
- using a transect line
- measuring the rate of photosynthesis

The course support notes provide a list of suggested learning activities. Choosing from the activities suggested in the course support notes, or carrying out any other appropriate activities, allows candidates to become familiar with the apparatus and techniques listed above. Where it is not possible to carry out a particular technique other resources could be utilised.

Skills, knowledge and understanding included in the course are appropriate to the SCQF level of the course. The SCQF level descriptors give further information on characteristics and expected performance at each SCQF level (www.scqf.org.uk).

# Skills for learning, skills for life and skills for work

This course helps candidates to develop broad, generic skills. These skills are based on SQA's Skills Framework: Skills for Learning, Skills for Life and Skills for Work and draw from the following main skills areas:

**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

These skills must be built into the course where there are appropriate opportunities and the level should be appropriate to the level of the course.

Further information on building in skills for learning, skills for life and skills for work is given in the course support notes.

# Course assessment

Course assessment is based on the information provided in this document.

The course assessment meets the key purposes and aims of the course by addressing:

- breadth — by drawing on knowledge and skills from across the course
- challenge — by requiring greater depth or extension of knowledge and/or skills
- application — by requiring application of knowledge and/or skills in experimental work/fieldwork and theoretical contexts and communicating findings

This enables candidates to:

- apply breadth and depth of skills, knowledge and understanding from across the course to answer questions in biology
- apply skills of scientific inquiry, using related knowledge, to carry out a meaningful and appropriately challenging task in biology and communicate findings

# Course assessment structure: question paper

## Question paper 100 marks

The purpose of the question paper is to assess breadth, challenge and application of skills, knowledge and understanding from across the course.

The question paper assesses the application or extension of knowledge and/or skills in unfamiliar situations, practical and theoretical contexts. The question paper also assesses scientific inquiry skills, analytical thinking skills, problem-solving skills and the impact of applications of biology on society and the environment.

The question paper gives candidates an opportunity to demonstrate the following skills, knowledge and understanding:

- demonstrating knowledge and understanding of biology by making statements, describing information, providing explanations and integrating knowledge
- applying knowledge of biology to new situations, interpreting information and solving problems
- planning and/or designing experimental/fieldwork investigations to test given hypotheses or to illustrate particular effects
- selecting information from a variety of sources
- presenting information appropriately in a variety of forms
- processing information (using calculations and units, where appropriate)
- making predictions and generalisations based on evidence/information
- drawing valid conclusions and giving explanations supported by evidence/justification
- suggesting improvements to experimental/fieldwork investigations

The question paper has a total of 100 marks and is worth 80% of the total marks for external assessment.

The question paper has two sections:

- Section 1 contains multiple-choice questions and has 25 marks.
- Section 2 contains structured and extended response questions and has 75 marks.

Marks are distributed proportionally across the course content.

The majority of marks are awarded for demonstrating and applying knowledge and understanding. The other marks are awarded for applying scientific inquiry, scientific analytical thinking, problem-solving skills and the impact of applications of biology on society and the environment.

## Setting, conducting and marking the question paper

The question paper is set and marked by SQA, and conducted in centres under conditions specified for external examinations by SQA. The question paper is 2 hours and 30 minutes in duration.

Specimen question papers for National 5 courses are published on SQA's website. These illustrate the standard, structure and requirements of the question papers candidates sit. The specimen papers also include marking instructions.

# Course assessment structure: assignment

## Assignment 20 marks

The purpose of the assignment is to assess the application of skills of scientific inquiry and related biology knowledge and understanding.

This component allows assessment of skills which cannot be assessed through the question paper; for example, the handling and processing of data gathered as a result of experimental work/fieldwork, and research skills.

### Assignment overview

The assignment gives candidates an opportunity to demonstrate the following skills, knowledge and understanding:

- applying knowledge of biology to new situations, interpreting information and solving problems
- planning, designing and safely carrying out experimental/fieldwork investigations to test given hypotheses or to illustrate particular effects
- selecting information from a variety of sources
- presenting information appropriately in a variety of forms
- processing information (using calculations and units, where appropriate)
- making predictions and generalisations based on evidence/information
- drawing valid conclusions and giving explanations supported by evidence/justification
- suggesting improvements to experimental/fieldwork investigations
- communicating findings/information

Candidates are required to:

- choose, with support, a relevant topic in biology
- devise an appropriate aim
- give an account of biology relevant to the aim
- plan and carry out experimental work/fieldwork to generate data relevant to the aim
- process and present the experimental/fieldwork data
- compare data/information from internet/literature research with the experimental/fieldwork data
- draw a conclusion
- evaluate the experimental/fieldwork procedure
- communicate the findings in a report

## Setting, conducting and marking the assignment

### Setting

The assignment is:

- set by centres within SQA guidelines
- set at a time appropriate to the candidates' needs
- set within teaching and learning and includes experimental work/fieldwork at a level appropriate to National 5

### Conducting

The assignment is:

- an individually produced piece of work from each candidate
- started at an appropriate point in the course
- conducted under controlled conditions

### Marking

The assignment has a total of 20 marks, which are allocated to the following sections:

| | Section of assignment | Marks |
|---|---|---|
| 1 | Aim | 1 |
| 2 | Underlying biology | 3 |
| 3 | Data collection and handling | 6 |
| 4 | Graphical presentation | 4 |
| 5 | Analysis | 1 |
| 6 | Conclusion | 1 |
| 7 | Evaluation | 2 |
| 8 | Structure | 2 |
| | **Total marks** | **20** |

The report is submitted to SQA for external marking.

All marking is quality assured by SQA.

## Assessment conditions

Controlled assessment is designed to:

- ensure that all candidates spend approximately the same amount of time on their assignments
- prevent third parties from providing inappropriate levels of guidance and input
- mitigate concerns about plagiarism and improve the reliability and validity of SQA awards
- allow centres a reasonable degree of freedom and control
- allow candidates to produce an original piece of work

### Time

It is recommended that no more than 8 hours is spent on the **whole** assignment. A maximum of 1 hour and 30 minutes is allowed for the report stage.

### Supervision, control and authentication

There are two levels of control.

| Under a high degree of supervision and control | Under some supervision and control |
|---|---|
| ♦ the use of resources is tightly prescribed<br>♦ all candidates are within direct sight of the supervisor throughout the session(s)<br>♦ display materials that might provide assistance are removed or covered<br>♦ there is no access to e-mail, the internet or mobile phones<br>♦ candidates complete their work independently<br>♦ interaction with other candidates does not occur<br>♦ no assistance of any description is provided | ♦ candidates do not need to be directly supervised at all times<br>♦ the use of resources, including the internet, is not tightly prescribed<br>♦ the work an individual candidate submits for assessment is their own<br>♦ teachers and lecturers can provide reasonable assistance |

The assignment has two stages.

| Stage | Level of control |
|---|---|
| ♦ research | conducted under some supervision and control |
| ♦ report | conducted under a high degree of supervision and control |

**Resources**

The only materials that **can** be used in the report stage are:

- the instructions for candidates, which must not have been altered
- the candidate's raw experimental/fieldwork data, which may be tabulated, however must not have additional blank or pre-populated columns for average and derived values
- comparative data/information from the internet or literature, which must not include sample calculations
- a record of the source of the comparative data/information
- the experimental/fieldwork method, if appropriate
- extract(s) from internet/literature source(s) to support the underlying biology, which must not include sample calculations

Candidates **must not** have access to a previously prepared draft of a report or any part of a report.

**Reasonable assistance**

Candidates must undertake the assessment independently. However, reasonable assistance may be provided prior to the formal assessment process taking place. The term 'reasonable assistance' is used to try to balance the need for support with the need to avoid giving too much assistance. If any candidates require more than what is deemed to be 'reasonable assistance', they may not be ready for assessment or it may be that they have been entered for the wrong level of qualification.

The assignment assessment task provides guidance on reasonable assistance.

## Evidence to be gathered

The following candidate evidence is required for this assessment:

- a report

The same report cannot be submitted for more than one subject.

### Volume

There is no word count.

# Grading

A candidate's overall grade is determined by their performance across the course assessment. The course assessment is graded A–D on the basis of the total mark for all course assessment components.

### Grade description for C

For the award of grade C, candidates will typically have demonstrated successful performance in relation to the skills, knowledge and understanding for the course.

### Grade description for A

For the award of grade A, candidates will typically have demonstrated a consistently high level of performance in relation to the skills, knowledge and understanding for the course.

# Equality and inclusion

This course is designed to be as fair and as accessible as possible with no unnecessary barriers to learning or assessment.

For guidance on assessment arrangements for disabled candidates and/or those with additional support needs, please follow the link to the assessment arrangements web page: www.sqa.org.uk/assessmentarrangements.

# Further information

The following reference documents provide useful information and background.

- National 5 Biology subject page
- Assessment arrangements web page
- Building the Curriculum 3–5
- Design Principles for National Courses
- Guide to Assessment
- SCQF Framework and SCQF level descriptors
- SCQF Handbook
- SQA Skills Framework: Skills for Learning, Skills for Life and Skills for Work
- Coursework Authenticity: A Guide for Teachers and Lecturers
- Educational Research Reports
- SQA Guidelines on e-assessment for Schools
- SQA e-assessment web page

# Appendix 1: course support notes

## Introduction

These support notes provide advice and guidance to teachers and lecturers on approaches to delivering the course. They also provide further detail on the depth of knowledge required for each key area of the course. They should be read in conjunction with this course specification and the specimen question paper and/or coursework.

Note: The depth of knowledge required for each key area of the course **can be assessed in the question paper**.

## Developing skills, knowledge and understanding

This section provides further advice and guidance about skills, knowledge and understanding that could be included in the course. Teachers and lecturers should refer to this course specification for the skills, knowledge and understanding for the course assessment. Course planners have considerable flexibility to select coherent contexts which will stimulate and challenge their candidates, offering both breadth and depth.

The 'Approaches to learning and teaching' section provides suggested activities that teachers and lecturers can build in to their delivery to develop these skills, knowledge and understanding.

## Approaches to learning and teaching

Teaching should involve an appropriate range of approaches to develop knowledge and understanding and skills for learning, life and work. This can be integrated into a related sequence of activities, centred on an idea, theme or application of biology, based on appropriate contexts. Learning should be experiential, active, challenging and enjoyable, and include appropriate practical activities and could be candidate-led. The use of a variety of active learning approaches is encouraged, including peer teaching and assessment, individual and group presentations, role-playing and game-based learning, with candidate-generated questions.

When developing biology courses there should be opportunities for candidates to take responsibility for their learning. Learning and teaching should build on candidates' prior knowledge, skills and experiences.

There should be flexibility and differentiation of tasks built into the course to allow candidates of differing abilities to demonstrate achievement.

An investigatory approach is encouraged in biology, with candidates actively involved in developing their skills, knowledge and understanding by investigating a range of relevant biology applications and issues. A holistic approach should be adopted to encourage simultaneous development of candidates' conceptual understanding and skills.

Where appropriate, investigative work/experiments in biology should allow candidates the opportunity to select activities and/or carry out extended study. Investigative and experimental work is part of the scientific method of working and can fulfil a number of educational purposes.

All learning and teaching should offer opportunities for candidates to work collaboratively. Practical activities and investigative work can offer opportunities for group work, which should be encouraged.

Group work approaches can be used across the course, where it is helpful to simulate real-life situations, share tasks and promote team-working skills.

Practical activities need to include the use of the apparatus listed and, where possible, the use of technology and equipment that reflects current scientific use in biology. Practical activities also need to allow candidates to become familiar with the techniques stated. Appropriate risk assessment must be undertaken.

Effective partnership working can enhance the learning experience. Where possible, locally-relevant contexts should be studied, with visits. Guest speakers from, for example, industry, further and higher education could be used to bring the world of biology into the classroom.

Information and Communications Technology (ICT) can make a significant contribution to practical work in biology, in addition to the use of computers as a learning tool. Computer interfacing equipment can detect and record small changes in variables allowing experimental results to be recorded over short periods of time, completing experiments in class time. Results can also be displayed in real-time helping to improve understanding. Data logging equipment and video cameras can be set up to record data and make observations over periods of time longer than a class lesson, which can then be subsequently downloaded and viewed for analysis.

Learning about Scotland and Scottish culture will enrich the learning experience and help candidates to develop the skills for learning, life and work they will need to prepare them for taking their place in a diverse, inclusive and participative Scotland and beyond. Where there are opportunities to contextualise approaches to learning and teaching to Scottish contexts, teachers and lecturers should consider this.

Assessment should be integral to and improve learning and teaching. The approach should involve candidates and provide supportive feedback. Self and peer-assessment techniques should be encouraged, wherever appropriate. Assessment information should be used to set learning targets and next steps.

As part of learning, teaching and preparation for assessment, it is recommended that candidates carry out several investigations that meet the requirements of the assignment, as stipulated in this course specification. This should help candidates develop the necessary skills and prepare them for subsequent assessment.

The key areas are from the course specification. The depth of knowledge required provides further detail of the key areas and an outline of the level of demand.

Note: The key areas **and** the depth of knowledge required **can be assessed in the question paper**.

Suggested learning activities are also provided. It is not compulsory that all are covered. The contexts for each key area are open to personalisation and choice, so centres may also devise their own learning activities. However, candidates must be given the opportunity to experience the use of the apparatus and the techniques listed below **as these can be assessed in the question paper**.

| **Cell biology** | | |
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| **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.<br><br>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, eg 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 (continued) | | |
|---|---|---|
| **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, eg examine electron micrographs of cell membranes or make models.<br>♦ Investigate the effect of ethanol and temperature on cells, eg 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 (eg beetroot), plant cell plasmolysis, mass changes in egg (shell removed by soaking in vinegar) in syrup/water. |
| d Osmosis is the movement of water molecules from a higher 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. Relationship between different concentrations of solutions and their effect on cells. | Details of the terms hypotonic, hypertonic and isotonic are not required. | |

| Cell biology (continued) | | |
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| **2 Transport across cell membranes (continued)** | | |
| 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, eg 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 which codes for a protein. | | ♦ Research the relationship between chromosomes, genes, DNA and protein to illustrate that genes are located on chromosomes.<br>♦ Construction of 2D or 3D DNA models. Paper models of base pairing or DNA sections.<br>♦ Carry out numeracy activities to determine base pair numbers from given information. |
| b Messenger RNA (mRNA) is a molecule which 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.<br><br>Further details of transcription and translation are not required. | |

| Cell biology (continued) | | |
|---|---|---|
| **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/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.<br><br>Diagrams to illustrate the stages in degradation and synthesis reactions.<br><br>Substrate —(Enzyme)→ Product | ♦ Experiments to investigate the specificity of enzymes.<br>♦ 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, eg pepsin/ lipase/amylase/catalase to investigate the effect of temperature/pH on activity.<br>♦ Effect of temperature and pH on egg white as a model for effect on proteins. |

| Cell biology (continued) | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **5 Genetic engineering**<br><br>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.<br>Use of enzymes in this process. | Names of particular enzymes are not required. | ♦ Research current genetic foods/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, eg insulin and growth hormone. |
| **6 Respiration**<br><br>a The chemical energy stored in glucose must be released by all cells through a series of enzyme-controlled reactions called respiration.<br><br>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.<br><br>Examples of energy uses given are not exhaustive. | ♦ Burning of food to show energy release.<br>♦ Use of hydrogen carbonate indicator to show respiration in living organisms.<br>♦ Use of simple respirometers to measure rate of respiration in, eg small invertebrates, germinating peas.<br>♦ Use of immobilised yeast and hydrogen carbonate indicator, resazurin or gas sensors and data loggers to investigate rate of respiration. |

| Cell biology (continued) | | |
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| **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 upon the presence/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. | Overall number of ATP molecules generated by aerobic respiration not required. | |
| 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. | Word summaries of the process of respiration:<br>Glucose + oxygen → carbon dioxide + water + energy<br>Glucose → carbon dioxide + ethanol + energy<br>Glucose → lactate + energy | |
| 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. | The higher the energy requirement of a cell the greater the number of mitochondria present in that cell. | |

| Biology: multicellular organisms | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **1 Producing new cells** | | |
| a Sequence of events of mitosis. Understanding of the terms chromatids, equator and spindle fibres. | Names of the phases are not required. | ♦ Select and present information using mitosis stage cards. Create model chromosomes.<br>♦ Observe prepared root tip cell slides/bioviewer. |
| b Mitosis provides new cells for growth, repair of damaged tissues and replacement of dead or damaged cells. It also maintains the diploid chromosome complement. | Diploid cells have two matching sets of chromosomes, which are replicated during mitosis. | ♦ Carry out numeracy activities based on cell growth graphs/curves. |
| c Stem cells in animals are unspecialised cells which can divide in order to self-renew. They have the potential to become different types of cell. Stem cells are involved in growth and repair. | Stem cells can be obtained from the embryo at a very early stage. In addition, tissue stem cells can be found in the body throughout life. The terms pluripotent, totipotent and multipotent are not required. | ♦ Use a variety of media to investigate the potential uses of stem cells and discuss ethical issues associated with their use. |
| d Specialisation of cells leads to the formation of a variety of cells, tissues and organs. Groups of organs which work together form systems.<br><br>A hierarchy exists:<br>cells → tissues → organs → systems | Multicellular organisms have more than one cell type and are made up of tissues and organs. Organs perform different functions. The cells in organs are specialised for their function and work together to form systems.<br><br>Details of organs which make up individual systems are not required. | ♦ Examine a variety of cells from different tissues to relate their structure to function. |

| Biology: multicellular organisms (continued) | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **2 Control and communication**<br><br>a **Nervous control** | A response to a stimulus can be a rapid action from a muscle or a slower response from a gland. | |
| i Nervous system consists of central nervous system (CNS) and other nerves. CNS consists of brain and spinal cord. Structure and function of parts of the brain — cerebrum, cerebellum and medulla. Neurons are of three types: sensory, inter and motor. Receptors detect sensory input/stimuli. Electrical impulses carry messages along neurons. Chemicals transfer these messages between neurons, at synapses. | Sensory neurons pass the information to the CNS. Inter neurons operate within the CNS, which processes information from the senses that require a response. Motor neurons enable a response to occur at an effector (muscle or gland). | ♦ Investigate reaction time in humans. |
| ii Structure and function of reflex arc. | Reflexes protect the body from harm. | ♦ Research/investigate examples of human reflex activities, eg blinking, iris reflex, response to pain. |
| b **Hormonal control** | | |
| i Endocrine glands release hormones into the bloodstream. Hormones are chemical messengers. A target tissue has cells with complementary receptor proteins for specific hormones, so only that tissue will be affected by these hormones. | Names and locations of individual endocrine glands, other than those mentioned in these course notes (pancreas, testes, ovaries), are not required. | |
| ii Blood glucose regulation. The roles of insulin, glucagon, glycogen, pancreas and liver. | Detail of negative feedback is not required. | ♦ Investigate the causes and treatment of type 1 and type 2 diabetes, with reference to trends in Scottish health statistics. |

| Biology: multicellular organisms (continued) | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **3 Reproduction** | | |
| a Cells are diploid, except gametes, which are haploid. | Knowledge of polyploidy is not required. | |
| b The types of gametes, the organs that produce them, and where these are located in plants and animals. The basic structure of sperm and egg cells. | Recognition of cells and organs involved from diagrams. | |
| c Fertilisation is the fusion of the nuclei of the two haploid gametes to produce a diploid zygote, which divides to form an embryo. | | |
| **4 Variation and inheritance** | | |
| a Comparison of discrete variation (single gene inheritance) and continuous variation (polygenic inheritance). | Combining genes from two parents contributes to variation within a species.<br><br>Single gene inheritance of characteristics showing discrete variation where measurements fall into distinct groups.<br><br>Polygenic inheritance of characteristics showing continuous variation where there is a range of values between a minimum and a maximum. | ♦ Investigate a variety of discrete and continuous characteristics in organisms, eg long and short hair in cats, dry and wet earwax in humans, height in humans, leaf length in plants. |

| Biology: multicellular organisms (continued) | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **4 Variation and inheritance (continued)** | | |
| b Understanding of genetic terms: gene; allele; phenotype; genotype; dominant; recessive; homozygous; heterozygous and P, $F_1$ and $F_2$. | Family trees and the identification of phenotypes and genotypes from them. | |
| c Monohybrid crosses from parental generation through to $F_2$ generation. | Carry out monohybrid crosses.<br>Use Punnett squares to explain inheritance. | |
| d Reasons why predicted phenotype ratios among offspring are not always achieved. | | |
| **5 Transport systems — plants** | . | |
| a Plant organs are roots, stems and leaves. Leaf structure diagram showing upper epidermis, palisade mesophyll, spongy mesophyll, vein (consisting of xylem and phloem), lower epidermis, guard cells and stomata. | | ♦ Stomatal models and use of leaf peels and microscopes to view stomata.<br>♦ Investigate number or distribution of stomata from different leaves/species.<br>♦ Microscope slides showing sections through leaf. |
| b Parts of the plant involved in water transport. Water and minerals enter the plant through the root hairs and are transported in dead xylem vessels. | | ♦ Germination of seeds to show root hairs. |
| Structure of xylem vessels. | Xylem cells are lignified to withstand the pressure changes as water moves through the plant. | ♦ Stain xylem vessels in celery using food colouring.<br>♦ Examine slides showing xylem structure. |

| Biology: multicellular organisms (continued) | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **5 Transport systems — plants (continued)** | | |
| c The process of transpiration and how the rate of transpiration is affected by wind speed, humidity, temperature and surface area. | Transpiration is the process of water moving through a plant and its evaporation through the stomata.<br><br>The structures and processes involved as water moves through the plant from the soil to the air.<br><br>Details of mechanism for opening/closing of stomata are not required.<br><br>Details of transpiration pull and the forces involved are not required.<br><br>External factors can increase or decrease rate of transpiration. Details of how this takes place are not required. | ♦ Transpiration experiments to show water loss using a weight or a bubble potometer.<br><br>♦ Investigate the effect of wind speed, humidity, temperature or surface area on transpiration. |
| d Sugar is transported up and down the plant in living phloem.<br>Structure of phloem tissue. | Phloem cells have sieve plates and associated companion cells. | ♦ Microscope slides showing phloem structure. |

| Biology: multicellular organisms (continued) | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **6 Transport systems — animals** | | |
| a In mammals the blood contains plasma, red blood cells and white blood cells. It transports nutrients, oxygen and carbon dioxide. | Information about platelets is not required. | ♦ Use of diagrams/models to illustrate the structure of blood cells. |
| b Red blood cells are specialised by being biconcave in shape, having no nucleus and containing haemoglobin. This allows them to transport oxygen efficiently in the form of oxyhaemoglobin. | oxygen + haemoglobin → oxyhaemoglobin | |
| c White blood cells are part of the immune system and are involved in destroying pathogens. There are two main types of cells involved. Phagocytes carry out phagocytosis by engulfing pathogens. Some lymphocytes produce antibodies which destroy pathogens. Each antibody is specific to a particular pathogen. | Pathogens are disease-causing micro-organisms (bacteria, viruses, fungi).<br><br>Process of phagocytosis — engulfing and digestion. Detail of lysis/lysosomes not required.<br><br>Detail of antibody structure not required. | |
| d Pathway of oxygenated and deoxygenated blood through heart, lungs and body. Diagram of heart to show the right and left atria, ventricles, location of four valves, location of associated blood vessels (aorta, vena cava, pulmonary artery, pulmonary vein and coronary arteries). Function of each of these parts. | Names of individual valves are not required. | ♦ Investigate heart structure through the use of dissection, models or films. |

| Biology: multicellular organisms (continued) | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **6 Transport systems — animals (continued)**<br><br>e Arteries have thick, muscular walls, a narrow central channel and carry blood under high pressure away from the heart. Veins have thinner walls, a wider channel and carry blood under low pressure back towards the heart. Veins contain valves to prevent backflow of blood. Capillaries are thin walled and have a large surface area, forming networks at tissues and organs to allow efficient exchange of materials.<br><br>**7 Absorption of materials**<br><br>a Oxygen and nutrients from food must be absorbed into the bloodstream to be delivered to cells for respiration. Waste materials, such as carbon dioxide, must be removed from cells into the bloodstream.<br><br>b Tissues contain capillary networks to allow the exchange of materials at cellular level.<br><br>c Surfaces involved in the absorption of materials have certain features in common: large surface area, thin walls, extensive blood supply. These increase the efficiency of absorption. | | ♦ Use of diagrams/models to illustrate the structure of arteries, veins and capillaries. |

| Biology: multicellular organisms (continued) | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **7 Absorption of materials (continued)** | | |
| d Lungs are gas exchange organs. They consist of a large number of alveoli providing a large surface area. Oxygen and carbon dioxide are absorbed through the thin alveolar walls to or from the many blood capillaries. | | ♦ Investigate lung structure through the use of dissection, models or films. |
| e Nutrients from food are absorbed into the villi in the small intestine. The large number of thin walled villi provides a large surface area. Each villus contains a network of capillaries to absorb glucose and amino acids and a lacteal to absorb fatty acids and glycerol. | | ♦ Investigate villus structure through the use of models and films. |

| Biology: life on Earth | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **1 Ecosystems**<br><br>a Definitions of ecological terms: species, biodiversity, population, producer, consumer, herbivore, carnivore, omnivore, predator, prey, food chain, food web.<br><br>b An ecosystem consists of all the organisms (the community) living in a particular habitat and the non-living components with which the organisms interact.<br><br>Interactions of organisms in food webs.<br><br>c A niche is the role that an organism plays within a community. It relates to the resources it requires in its ecosystem, such as light and nutrient availability and its interactions with other organisms in the community. It involves competition and predation and the conditions it can tolerate such as temperature. | Effects of removal of organism(s) from a food web. | ♦ Research a variety of ecosystems and the organisms found in them.<br><br>♦ Investigate examples of niches of Scottish wildlife, eg wildcat, red squirrel, red grouse, Scottish crossbill, brown trout, and bracken.<br><br>♦ Analyse data related to distribution of barnacles on rocky shores, native woodland and red deer numbers, distribution of ptarmigan. |

| Biology: life on Earth (continued) | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **1 Ecosystems (continued)** | | |
| d Competition in ecosystems occurs when resources are in short supply. Interspecific competition occurs amongst individuals of different species for one or a few of the resources they require. Intraspecific competition occurs amongst individuals of the same species and is for all resources required. Intraspecific competition is therefore more intense than interspecific competition. | | ♦ Investigate interspecific competition in animals, eg red and grey squirrels, brown and rainbow trout.<br>♦ Investigate interspecific competition in plants, eg a variety of different seeds grown together.<br>♦ Investigate intraspecific competition, eg cress seedling density, trees of the same species growing close together. |
| **2 Distribution of organisms** | | |
| a Competition for resources, disease, food availability, grazing and predation are biotic factors. Light intensity, moisture, pH and temperature are abiotic factors. | | ♦ Interpret predator prey interaction graphs. |
| b Measuring abiotic factors such as light intensity, soil moisture, pH and temperature. Possible sources of error and how to minimise them. | | ♦ Use of techniques for abiotic factors: temperature using thermometer or temperature probes, light using light meters, moisture using moisture meters, pH using pH meters or chemical test.<br>♦ Use of probes linked to appropriate data logging software. |

| Biology: life on Earth (continued) | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **2 Distribution of organisms (continued)** | | |
| c Sampling of plants and animals using quadrats and pitfall traps. Evaluation of limitations and sources of error in their use. | The need for representative sampling and adequate replication. | ♦ Investigate the abundance of plants/invertebrates in an area.<br>♦ Investigate the distribution of a species in an ecosystem using a line transect. |
| d Using and constructing paired-statement keys to identify organisms. | | |
| e The effect of biotic and abiotic factors on biodiversity and the distribution of organisms. | Factors which can cause an increase or a decrease in biodiversity. | ♦ Investigate the effect of light/moisture on the abundance of plants in an area.<br>♦ Investigate a range of human influences that affect environments such as: pollution of air and water, habitat destruction by, eg deforestation (tropical rain forest), desertification, overfishing.<br>♦ Research human activities which cause species to become endangered. |
| f Indicator species are species that by their presence or absence indicate environmental quality/levels of pollution. | | ♦ Investigate the effect of air pollution on lichens.<br>♦ Investigate the effect of organic pollution on freshwater organisms. |

| Biology: life on Earth (continued) | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **3 Photosynthesis**<br><br>a Photosynthesis is a two-stage process:<br><br>i Light reactions: the light energy from the sun is trapped by chlorophyll in the chloroplasts and is converted into chemical energy which is used to generate ATP. Water is split to produce hydrogen and oxygen. Oxygen diffuses from the cell.<br><br>ii Carbon fixation: a series of enzyme-controlled reactions, which use hydrogen and ATP (produced by the light reactions) with carbon dioxide to produce sugar. | Word summary of the process of photosynthesis:<br><br>Carbon dioxide + water $\xrightarrow{\text{Light energy}}$ sugar + oxygen | |
| b The chemical energy in sugar is available for respiration or the sugar can be converted into other substances, such as starch (storage) and cellulose (structural). | | ♦ Factors affecting starch production can be investigated through iodine testing in leaves. |
| c Limiting factors: carbon dioxide concentration, light intensity and temperature and their impact on photosynthesis and plant growth.<br><br>Analysis of limiting factors graphs. | | ♦ Investigate limiting factors through experiments with *Elodea*, immobilised algae or the use of IT simulations. |

| Biology: life on Earth (continued) | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **4 Energy in ecosystems**<br><br>a In transfers from one level to the next in a food chain, the majority of the energy is lost as heat, movement or undigested materials. Only a very small quantity is used for growth and is therefore available at the next level in a food chain.<br><br>b Definitions and comparisons of pyramids of numbers and energy. | Irregular shapes of pyramids of numbers based on different body sizes can be represented as true pyramids of energy. | ♦ Investigate examples of pyramid of energy (as measured in kJ/$m^2$/year) and pyramid of numbers.<br><br>♦ Investigate irregular pyramids of number, eg a tree as a producer, presence of parasites. |

| Biology: life on Earth (continued) | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **5 Food production**<br><br>a Increasing human population requires an increased food yield. This can involve the use of fertilisers and pesticides. Fertilisers provide chemicals such as nitrates which increase crop yield. Plants and animals which reduce crop yield can be killed by pesticides.<br><br>b Nitrates dissolved in soil water are absorbed into plants. Nitrates are used to produce amino acids which are synthesised into plant proteins. Animals consume plants or other animals to obtain amino acids for protein synthesis. Fertilisers can be added to soil to increase the nitrate content of the soil.<br><br>c Fertilisers can leach into fresh water, adding extra, unwanted nitrates. This will increase algal populations which can cause algal blooms. Algal blooms reduce light levels, killing aquatic plants. These dead plants, as well as dead algae, become food for bacteria which increase greatly in number. The bacteria use up large quantities of oxygen, reducing the oxygen availability for other organisms. Genetically modified (GM) crops can be used to reduce the use of fertilisers. | Details of the full nitrogen cycle are not required. | ♦ Investigate the effect of fertilisers on plant growth.<br><br>♦ Investigate the effect of fertiliser concentration on algal growth. |

| Biology: life on Earth (continued) | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **5 Food production (continued)**<br><br>d Pesticides sprayed onto crops can accumulate in the bodies of organisms over time. As they are passed along food chains, toxicity increases and can reach lethal levels.<br><br>The use of biological control and genetically modified (GM) crops as alternatives to the use of pesticides. | The build-up of toxic substances in living organisms is known as bioaccumulation. | ♦ Research GM crops which can reduce fertiliser use.<br><br>♦ Research bioaccumulation through former use of DDT, lead (from leaded petrol) and mercury.<br><br>♦ Research biological control, eg using a virus (eg calicivirus) to kill rabbits; using ladybirds to kill aphids and scale insects; using caterpillar moth (*Cactoblastis*) to kill cacti (*Opuntia*).<br><br>♦ Investigate GM rice plants which take up nitrogen more efficiently.<br><br>♦ Research Bt toxin in tomatoes as alternative to pesticides. |

| Biology: life on Earth (continued) | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **6 Evolution of species** | | |
| a A mutation is a random change to genetic material. Mutations may be neutral, confer an advantage or a disadvantage to survival. Mutations are spontaneous and are the only source of new alleles.<br>Environmental factors, such as radiation and some chemicals, can increase the rate of mutation. | | ♦ Research different types of mutation — neutral, advantageous or disadvantageous.<br>♦ Research mutagenic agents. |
| b New alleles produced by mutation can result in plants and animals becoming better adapted to their environment. Variation within a population makes it possible for a population to evolve over time in response to changing environmental conditions. | An adaptation is an inherited characteristic that makes an organism well suited to survival in its environment/niche. | ♦ Investigate examples of adaptations such as desert mammals and plants and Galapagos finches. |
| c Species produce more offspring than the environment can sustain. Natural selection or survival of the fittest occurs when there are selection pressures. The best adapted individuals in a population survive to reproduce, passing on the favourable alleles that confer the selective advantage. These alleles increase in frequency within the population. | | ♦ Research consequences of over-prescription of antibiotics. |

| Biology: life on Earth (continued) | | |
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| **Key areas** | **Depth of knowledge required** | **Suggested learning activities** |
| **6 Evolution of species (continued)**<br><br>d Speciation occurs after part of a population becomes isolated by an isolation barrier, which can be geographical, ecological or behavioural. Different mutations occur in each sub-population. Natural selection selects for different mutations in each group, due to different selection pressures. Each sub-population evolves until they become so genetically different that they are two different species. | Examples of each type of barrier, eg ecological — pH, salinity or different habitats. | ♦ Research Scottish examples of isolation leading to speciation, eg Arran Whitebeam, St Kilda Wren, Arctic Char.<br><br>♦ Research examples of rapid natural selection, eg MRSA, insect resistance to GM crop toxins. |

**Apparatus and techniques**

In addition to the key areas, candidates must have knowledge of the following pieces of apparatus and have opportunities to become familiar with the following techniques.

Note: The apparatus and techniques noted below **can be assessed in the question paper**.

**Apparatus**

- beaker
- balance
- measuring cylinder
- dropper/pipette
- test tube/boiling tube
- thermometer
- funnel
- syringe
- timer/stopwatch
- microscope
- petri dish
- quadrat
- pitfall trap
- light/moisture meter
- water bath

**Techniques**

- measuring enzyme activity
- using a respirometer
- measuring transpiration using a potometer
- measuring abiotic factors
- measuring the distribution of a species
- using a transect line
- measuring the rate of photosynthesis

Choosing from the suggested learning activities, or carrying out any other appropriate activities, allows candidates to become familiar with the apparatus and techniques listed above. Where it is not possible to carry out a particular technique other resources could be utilised.

Candidates should be familiar with the terms ‘control’, ‘validity’, and ‘reliability’ and be able to comment on these in experimental set-up questions.

Control: set up to compare results of an experiment when no treatment is applied.

Validity: other variables are controlled to ensure any effect is likely to be due to the variable being changed.

Reliability: where consistent values in repeats of experiments are obtained.

# Preparing for course assessment

Each course has additional time which may be used at the discretion of teachers and lecturers to enable candidates to prepare for course assessment. This time may be used at various points throughout the course for consolidation and support. It may also be used towards the end of the course, for further integration, revision and preparation.

During delivery of the course, opportunities should be found:

- for identification of particular aspects of work requiring reinforcement and support
- to practise skills of scientific inquiry and investigation in preparation for the assignment
- to practise question paper techniques

# Developing skills for learning, skills for life and skills for work

Course planners should identify opportunities throughout the course for candidates to develop skills for learning, skills for life and skills for work.

Candidates should be aware of the skills they are developing and teachers and lecturers can provide advice on opportunities to practise and improve them.

SQA does not formally assess skills for learning, skills for life and skills for work.

There may also be opportunities to develop additional skills depending on approaches being used to deliver the course in each centre. This is for individual teachers and lecturers to manage.

Candidates are expected to develop broad generic skills as an integral part of their learning experience. This course specification lists the skills for learning, skills for life and skills for work that candidates should develop through this course. These are based on SQA's Skills Framework: Skills for Learning, Skills for Life and Skills for Work and must be built into the course where there are appropriate opportunities. The level of these skills will be appropriate to the level of the course.

For this course, it is expected that the following skills for learning, skills for life and skills for work will be significantly developed:

**Numeracy**
This is the ability to use numbers to solve problems by counting, doing calculations, measuring, and understanding graphs and charts. This is also the ability to understand the results. Candidates will have opportunities to extract, process and interpret information presented in numerous formats including tabular and graphical. Experimental work/fieldwork will provide opportunities to develop time and measurement skills.

**2.1 Number processes**
Number processes means solving problems arising in everyday life through carrying out calculations, when dealing with data and results from experiments/fieldwork and everyday class work, making informed decisions based on the results of these calculations and understanding these results.

**2.2 Money, time and measurement**
This means using and understanding time and measurement to solve problems and handle data in a variety of biology contexts, including experiments and fieldwork.

**2.3 Information handling**
Information handling means being able to interpret biological data in tables, charts and other graphical displays to draw sensible conclusions throughout the course. It involves interpreting the data and considering its reliability in making reasoned deductions and informed decisions. It also involves an awareness and understanding of the chance of events happening.

**Thinking skills**
This is the ability to develop the cognitive skills of remembering and identifying, understanding and applying. The course will allow candidates to develop skills of applying, analysing and evaluating. Candidates can analyse and evaluate experiments/fieldwork and data by reviewing the process, identifying issues and forming valid conclusions. They can demonstrate understanding and application of concepts and explain and interpret information and data.

**5.3 Applying**
Applying is the ability to use existing information to solve biological problems in different contexts, and to plan, organise and complete a task such as an investigation.

**5.4 Analysing and evaluating**
Analysis is the ability to solve problems in biology and make decisions that are based on available information.

It may involve the review and evaluation of relevant information and/or prior knowledge to provide an explanation.

It may build on selecting and/or processing information, so is a higher skill.

In addition, candidates will also have opportunities to develop literacy skills, working with others, creating and citizenship.

**Literacy**
Candidates will develop literacy skills to effectively communicate key biology concepts and describe clearly biology issues in various media forms. Candidates will have opportunities to communicate knowledge and understanding. Candidates will have opportunities to develop listening and reading skills when gathering and processing information.

**Working with others**
Learning activities provide many opportunities, in all areas of the course, for candidates to work with others. Practical activities, in particular, offer opportunities for group work, which is an important aspect of biology and should be encouraged.

**Creating**
Through learning in biology, candidates can demonstrate their creativity. In particular, when planning and designing experiments/fieldwork candidates have the opportunity to be innovative in their approach. Candidates also have the opportunities to make, write, say or do something new.

**Citizenship**
Candidates will develop citizenship skills when considering the applications of biology on our lives.

# Appendix 2: question paper brief

| | Marks | | |
|---|---|---|---|
| **Component** | **Knowledge and understanding** | **Skills** | **Total** |
| question paper | 70+/-5 | 30+/-5 | 100 |

| **Knowledge and understanding/skills** | **Range of marks** |
|---|---|
| ♦ demonstrating knowledge and understanding of biology by making statements, describing information, providing explanations and integrating knowledge | min 25 |
| ♦ applying knowledge and understanding of biology to new situations, interpreting information and solving problems | min 25 |
| ♦ planning and designing experimental/fieldwork investigations to test given hypotheses or to illustrate particular effects | 25–35 |
| ♦ selecting information from a variety of sources | |
| ♦ presenting information appropriately in a variety of forms | |
| ♦ processing information (using calculations and units, where appropriate) | |
| ♦ making predictions and generalisations based on evidence/information | |
| ♦ drawing valid conclusions and giving explanations supported by evidence/justification | |
| ♦ suggesting improvements to experimental/fieldwork investigations | |

## Additional information

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| A maximum of two extended writing questions of 3–5 marks. |
| At least one question based on scientific literacy. |
| Grade-A marks: approximately 25%. |

# Administrative information

**Published:** August 2022 (version 4.2)

## History of changes to course specification

| Version | Description of change | Date |
|---|---|---|
| 2.0 | Course support notes added as appendix. | June 2017 |
| 2.1 | Question paper brief added as appendix 2. | September 2017 |
| 3.0 | 'Course assessment structure: assignment' section: minor amendments to pages 17–19 to clarify resources for the report stage. | October 2018 |
| 4.0 | 'Biology: multicellular organisms: producing new cells' key area in 'Skills, knowledge and understanding for the course assessment' section and Appendix 1: course support notes, 'Approaches to learning and teaching' section: description of mitosis rephrased.<br><br>'Assessment conditions' section: assignment assessment conditions for teachers, lecturers and candidates clarified. | September 2019 |
| 4.1 | Appendix 1: course support notes, 'Approaches to learning and teaching' section: error in 'suggested learning activities' column in table on page 35 changed from 'bubble photometer' to 'bubble potometer'. | October 2021 |
| 4.2 | Appendix 1: course support notes, 'Apparatus and techniques' section updated to include definitions of the terms, 'control', 'validity', and 'reliability'.<br><br>Appendix 2: question paper brief, 'Additional information' section updated to amend percentage of grade-A marks to 'approximately 25%'. | August 2022 |