National Unit specification

General information

Unit title: Introducing Microbiology (SCQF level 5)

Unit code: HL95 45

Superclass: RH

Publication date: September 2017

Source: Scottish Qualifications Authority

Version: 2

Unit purpose

This unit is designed to provide learners with an understanding of the features of microorganisms. Learners will also develop the practical skills necessary for carrying out aseptic technique. This 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 microbiology at HNC level.

Outcomes

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

1 Outline the features of microorganisms.
2 Describe beneficial and detrimental effects of microorganisms.
3 Sample the environment for microorganisms.
4 Produce an uncontaminated pure culture on a solid medium from a given stock culture also on a solid medium.

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, however it is recommended that learners should have prior knowledge of Biology at SCQF level 4 or equivalent.

National Unit specification: General information (cont)

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Core Skills

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

Complete Core Skill None

Core Skill component *Critical Thinking* at SCQF level 4

There are also opportunities to develop aspects of Core Skills which are highlighted in the support notes of this unit specification.

Context for delivery

If this unit is delivered as part of a group award, it is recommended that it should be taught and assessed within the subject area of the group award to which it contributes.

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

Outline the features of microorganisms.

Performance criteria

(a) The categorisation of microorganisms into algae, bacteria, fungi, protozoa and viruses is correct with respect to:
   (i) morphological features
   (ii) the reasons given for each designation

(b) The description of the culture requirements of algae, bacteria, fungi and protozoa is correct with respect to:
   (i) nutrition
   (ii) light
   (iii) temperature
   (iv) moisture

(c) The description of the culture requirements of viruses is correct with respect to their need for living cells.

Outcome 2

Describe beneficial and detrimental effects of microorganisms.

Performance criteria

(a) The description of the beneficial effects of microorganisms is complete in terms of:
   (i) a named organism from each of the five groups (algae, bacteria, fungi, protozoa and viruses)
   (ii) the way in which each organism is exploited

(b) The description of the detrimental effects of microorganisms is complete in terms of:
   (i) a named organism from each of the five groups (algae, bacteria, fungi, protozoa and viruses)
   (ii) the way in which each organism is deemed to be detrimental

National Unit specification: Statement of standards (cont)

Unit title: Introducing Microbiology (SCQF level 5)

Outcome 3

Sample the environment for microorganisms.

Performance criteria

(a) The preparation for each procedure used to take samples of air and surfaces is:
  (i) in accordance with given specifications
  (ii) correct with respect to selection of sampling site

(b) The procedures used to take samples of air and surfaces are:
  (i) in accordance with current safe practices
  (ii) correct with respect to use of equipment

(c) The recorded results are in an appropriate format.

(d) The interpretation of results is correct with respect to identification of factors that might affect the samples.

(e) The conclusions drawn are valid.

Outcome 4

Produce an uncontaminated pure culture on a solid medium from a given stock culture also on a solid medium.

Performance criteria

(a) The preparation for the procedure is correct with respect to:
  (i) personal preparation (hand washing, hair tying, protective clothing)
  (ii) preparation of work surface
  (iii) preparation of equipment

(b) The procedure used to obtain an uncontaminated inoculum is correct with respect to:
  (i) use of aseptic techniques
  (ii) use of inoculating loop
  (iii) plate inoculation
  (iv) sterilisation of inoculating loop after use

(c) The procedure used to produce an uncontaminated subculture from the inoculum is correct with respect to:
  (i) use of aseptic technique
  (ii) closing and labelling of subculture
  (iii) incubation of subculture

(d) The subculture produced is uncontaminated.

(e) The procedures used are in accordance with current safe practices.

National Unit specification: Statement of standards (cont)

Unit title: Introducing Microbiology (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 and 2 could be assessed using a holistic closed-book assessment under supervised conditions. Outcomes may be assessed individually. It is recommended that the assessment whether holistically or individually be completed within 45 minutes.

Written and/or oral recorded evidence for Outcomes 3 and 4 should be assessed by the completion of appropriate pro formas.

Outcome 1

A learner's response will be judged satisfactory where the evidence shows that the learner can:

- categorise five microorganisms correctly into algae, bacteria, fungi, protozoa and viruses. The learner must state for each specimen one reason, evident from the specimens, as to why the categorisation was made.
- describe correctly the culture requirements of algae, bacteria, fungi and protozoa with respect to: nutrition; light; temperature; moisture.
- describe correctly the culture requirements of viruses with respect to their need for living cells.

Outcome 2

A learner's response will be judged satisfactory where the evidence shows that the learner can:

- describe the beneficial effects of microorganisms in terms of:
  (i) a named organism from each of the five groups (algae, bacteria, fungi, protozoa and viruses)
  (iii) the way in which each organism is exploited

- describe the detrimental effects of microorganisms in terms of:
  (i) a named organism from each of the five groups (algae, bacteria, fungi, protozoa and viruses)
  (ii) the way in which each organism is deemed to be detrimental

For named organisms, common names and/or genus names are acceptable. Identification to species level is not required.

National Unit specification: Statement of standards (cont)

Unit title: Introducing Microbiology (SCQF level 5)

Outcome 3

Learners will perform four practical experiments to assess their ability to use the correct procedures to sample the environment for microorganisms. Learners will be required to take air samples from two different locations using sterile prepared Nutrient Agar plates, and surface samples from two different locations using sterile prepared Nutrient Agar plates.

A learner's response will be judged satisfactory where the evidence shows that the learner can:

- prepare for each procedure in accordance with given specifications and with respect to selection of sampling site
- take samples in accordance with current safe practices and with respect to the correct use of equipment
- record results in an appropriate format.
- interpret results correctly with respect to identification of factors that might affect the samples.
- draw valid conclusions

Learners must achieve all of the above evidence requirements for all four samples (two air samples and two surface samples).

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

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

Outcome 4

Learners will perform one practical experiment to assess their ability to use the correct procedures to produce one uncontaminated subculture from a given pure culture.

A learner's response will be judged satisfactory where the evidence shows that the learner can:

- prepare for the procedure correctly with respect to:
  (i) personal preparation (hand washing, hair tying, protective clothing)
  (ii) preparation of work surface
  (iii) preparation of equipment

- use the procedure correctly to obtain an uncontaminated inoculum with respect to:
  (i) use of aseptic techniques
  (ii) use of inoculating loop
  (iii) plate inoculation
  (iv) sterilisation of inoculating loop after use

- use the procedure correctly to produce an uncontaminated subculture from the inoculum with respect to:
  (i) use of aseptic technique
  (ii) closing and labelling of subculture
  (iii) incubation of subculture

- produce an uncontaminated subculture.

- use procedures in accordance with current safe practices.

An assessor observation checklist will be used to record the learner's performance of the practical work in line with given instructions and health and safety requirements. The checklist should include a visual check for contamination.

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

National Unit Support Notes

Unit title: Introducing Microbiology (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 NC Applied Sciences but may be suitable for inclusion in other science awards. It is designed to provide learners with an understanding of the features of microorganisms and to develop the practical skills necessary for carrying out aseptic technique.

Outcome 1 — Outline the features of microorganisms

The definition and range of microorganisms (algae, bacteria, fungi, protozoa, and viruses) should be established. Classification should be restricted to the main features of each of the groups and include morphological features of major taxonomic importance, eg the type of cell wall, presence of chloroplasts, etc. Detail needed for classification at the species level is not required. Cultural requirements should be mentioned where these are of fundamental importance to the group, eg algae, usually aquatic, photosynthetic; fungi, usually saprophytic; viruses, parasitic, etc.

Emphasis should be placed on those organisms which are of economic or medical importance, eg sources of mycoproteins, antibiotics, causes of diseases, rots, roles in nutrient cycles, industrial applications, etc.

Outcome 2 — Describe beneficial and detrimental effects of microorganisms

The beneficial and detrimental effects of all five groups of microorganisms on humans should be described. Named examples of an organism in each group should be chosen. Common names and/or genus names are acceptable. Identification to species level is not required.

Suggested examples of organisms with beneficial effects on humans that may be covered are:

- Algae — Biofuel production (*Botrytococcus braunii*), Production of Agar (*Gelidium sp.*)
- Bacteria — Genetic engineering (*E. coli*), yoghurt production (*Lactobacillus bulgaricus*), nutrient recycling (various, eg *Rhizobium sp.*)
- Fungi — Brewing and Baking industries, eg *Sacharomyces cerevisiae* and *Sacharromyces carlsbergenesis*, Nutrient recycling (various, eg *Rhizopus stolonifer*)
- Protozoa — Model organisms for research (*Dictyostelium discoideum*)
- Viruses — Vaccine production (Influenza virus), gene therapy vectors (Herpes simplex virus)

National Unit Support Notes (cont)

Unit title: Introducing Microbiology (SCQF level 5)

Suggested examples of organisms with detrimental effects on humans that may be covered are:

- Algae — Algal blooms (C*hlorella sp.*)
- Bacteria — Pathogens, eg *Vibrio cholera*, Salmonella sp., Food spoilage, eg *Erwina carotovora*
- Fungi — Pathogens, eg *Trichophyton sp.*, Food spoilage, eg *Rhizpous stolonifer*
- Protozoa — Pathogens, eg *Plasmodium sp., Cryptosporidium sp*
- Viruses — Pathogens, eg Measles virus, HIV, etc

Outcome 3 — Sample the environment for microorganisms

The aim of this outcome is to demonstrate the ubiquity of microorganisms and to illustrate the need in Outcome 4 for good aseptic techniques to avoid contamination.

Sampling should only be attempted once a clear understanding of safe and unsafe sites has been established.

Under no circumstances should samples be taken from areas such as human/animal body surfaces, body fluids or secretions, lavatories, animal cages/aquaria, meat/meat products, eggs, milk, mud, and other similar places likely to present a high risk of yielding pathogens.

Samples should be taken using both sterile swabs and settle plates and these techniques related to their particular uses.

Outcome 4 — Produce an uncontaminated pure culture on a solid medium from a given stock culture also on a solid medium

Proper aseptic techniques should be established from the outset. All aspects of good microbiological practice should be constantly enforced, beginning with hand washing and bench preparation at the start of the practical session, through to writing up evidence at the end. On no account should any hand to mouth operations be permitted in the laboratory and nothing other than proper microbiological procedures should be adopted. The use of Nutrient Agar should be related to Outcome 1.

Guidance on approaches to delivery of this unit

The emphasis in the delivery of the unit should be in the development of safe, consistent, practical skills and the learner should have several opportunities to practise skills. The outcomes of the unit should be integrated so as to develop a general awareness of the range of microorganisms and the need for a disciplined approach to working with microorganisms.

National Unit Support Notes (cont)

Unit title: Introducing Microbiology (SCQF level 5)

Outcomes 1 and 2

The learner's awareness of microbiology and microbiological techniques should be developed along with a sound understanding of the reasons for good aseptic techniques. A variety of approaches could be adopted, depending on resources. A learner-centred approach is recommended, for example by using prepared slides and photomicrographs, videos, guest speakers, industrial visits and individual assignments. A series of simple practical demonstrations could illustrate the differing cultural requirements of some of the microorganism groups, while the conditions required by the others could be found by reference to appropriate texts.

Outcome 3

At all times account must be taken of current safety guidelines and the risk of accidentally culturing pathogenic organisms. It is therefore essential that prior to the learner undertaking the sampling exercises this outcome is delivered to establish the criteria for safe and unsafe sampling sites. There is no need for the learners to have prepared the media or to have poured the plates themselves. The various uses of the sampling techniques, settle plate and surface sampling and their limitations could be established by group discussion once the results of the exercise are seen.

Outcome 4

The techniques to be used in the practical experiment should be demonstrated in a sequential manner with brief explanations at each step. Questioning of the learners as they undertake the exercise would help to ensure understanding.

It is recommended that where possible learners should be given their own stock culture from which they are to subculture. It is essential that only pure stock cultures are used.

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 and 2 could be assessed by a single holistic closed-book assessment with an appropriate cut-off score. Outcomes may be assessed individually. Assessment should be carried out in supervised conditions, and it is recommended that the assessment whether holistically or individually be completed within 45 minutes.

In Outcome 3 learners are required to undertake four assessed practical experiments, and learners must achieve all of the evidence requirements for all four samples (two air samples and two surface samples). Examples of suitable experiments are given below. However, this list is not prescriptive, and other practical experiments of similar complexity may be used by the centre.

National Unit Support Notes (cont)

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Suitable practical experiments for Outcome 3 are:

- Sampling microorganisms from areas around the laboratory, coins, bank notes, mobile phones, etc using sterile swabs.
- Settle plates left in various parts of the laboratory to sample microorganisms present in the air.
- Settle plates placed at various distances from the Bunsen burner on a roaring flame to demonstrate the importance of working close to the Bunsen flame.

In Outcome 4 learners are required to undertake one assessed practical experiment. Learners could be provided with either a pure culture of bacteria, eg *E. coli* on an agar plate or be provided with a mixed culture of bacteria, eg *Micrococcus luteus* and *Micrococcus roseus* on the same agar plate. Using the streak plate method pure cultures could then be produced by the learner. Learners may take several attempts to master this technique therefore this outcome should be introduced at the earliest opportunity. Other practical experiments of similar complexity may be used by the centre.

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

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**.

National Unit Support Notes (cont)

Unit title: Introducing Microbiology (SCQF level 5)

Opportunities for developing Core and other essential skills

This unit has the *Critical Thinking* component of *Problem Solving* embedded in it. This means that when learners achieve the unit, their Core Skills profile will also be updated to show they have achieved *Critical Thinking* at SCQF level 4

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 (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.

History of changes to unit

Version	Description of change	Date
2	Core Skills Component Critical Thinking at SCQF level 4 embedded.	12/09/2011

General information for learners

Unit title: Introducing Microbiology (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 an NC Applied Sciences programme. Before progressing to this unit it would be beneficial to have studied Biology at SCQF level 4, where you will have been introduced to underpinning aspects such as cell structure and developed your practical laboratory skills.

On completion of this unit you should be able to:

1 Outline the features of microorganisms.
2 Describe beneficial and detrimental effects of microorganisms.
3 Sample the environment for microorganisms.
4 Produce an uncontaminated pure culture on a solid medium from a given stock culture also on a solid medium.

Outcome 1

In this outcome you will be introduced to the five main groups of microorganisms (algae, bacteria, fungi, protozoa and viruses). You will learn the features that distinguish the different microorganisms from each other. You will also be introduced to the different growth requirements required by different microorganisms, eg nutrients, temperature, light, moisture.

Outcome 2

In this outcome you will learn about the beneficial and detrimental effects of microorganisms. While you may be familiar with many of the detrimental effects of microorganisms, eg bacteria and viruses that cause disease, this outcome will introduce you to many of the beneficial effects of microorganisms that are essential for life.

Outcome 3

In this outcome you will sample microorganisms (bacteria/fungi) from the air and from surfaces and culture them on agar plates. This will highlight to you that microorganisms are all around you and the importance of aseptic techniques when working with microorganisms to prevent contamination.

Outcome 4

In this outcome you will produce a pure culture of bacteria which has been grown on a solid plate. The ability to produce a pure culture of bacteria is a key skill for any microbiologist. You will also further develop your aseptic techniques and basic practical skills in microbiology.

General information for learners (cont)

Unit title: Introducing Microbiology (SCQF level 5)

Assessment

For Outcomes 1 - 2, depending on which centre you attend, assessment may be conducted on an outcome by outcome basis or by one single assessment. Assessment will be conducted under closed-book conditions.

Outcome 3 will be assessed after you have learned the necessary practical skills, and will take the form of four practical experiments, for which you will report your results by completion of pro forma reports.

Outcome 4 will be assessed after you have learned the necessary practical skills, and will take the form of one practical experiment, for which you will report your results by completion of a pro forma report.

Core Skills

This unit has the *Critical Thinking* component of *Problem Solving* embedded in it. This means that when you achieve the unit, your Core Skills profile will also be updated to show you have achieved *Critical Thinking* at SCQF level 4.

You will also have opportunities to develop the Core Skills of *Numeracy, Working with Others* and *Information and Communication (ICT)* at SCQF level 4.