



Higher National Unit Specification

General information

Unit title: Microbiological Techniques (SCQF level 8)

Unit code: J2GM 35

Superclass: RH

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Version: 02

Unit purpose

This unit is designed to enable learners to understand key aspects of microbiology, encompassing variation in micro-organisms, clinical microbiology and infection, and cellular microbiology. Learners will also develop practical skills in techniques relevant to microbiology. The unit is suitable for learners studying at HND level, and will provide the necessary underpinning knowledge and skills to enable progression to further study of microbiology at degree level or to seek employment in science based industries.

Outcomes

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

- 1 Explain mechanisms of variation in micro-organisms.
- 2 Explain aspects of clinical microbiology and infection.
- 3 Explain aspects of cellular microbiology.
- 4 Perform practical experiments related to microbiology.

Credit points and level

2 Higher National Unit credits at SCQF level 8: (16 SCQF credit points at SCQF level 8)

Recommended entry to the unit

Entry is at the discretion of the centre, however it is recommended that learners should have completed the HN Unit H92G 34 *Microbiology: Theory and Laboratory Skills* or equivalent.

Higher 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:

Core Skill component Critical Thinking at SCQF level 6

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.

The Assessment Support Pack (ASP) for this unit provides assessment and marking guidelines that exemplify the national standard for achievement. It is a valid, reliable and practicable assessment. Centres wishing to develop their own assessments should refer to the ASP to ensure a comparable standard. A list of existing ASPs is available to download from SQA's website (<http://www.sqa.org.uk/sqa/46233.2769.html>).

Equality and inclusion

This unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website www.sqa.org.uk/assessmentarrangements.

Higher 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.

Where evidence for outcomes is assessed on a sample basis, the whole of the content listed in the knowledge and/or skills section must be taught and available for assessment. Learners should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Explain mechanisms of variation in micro-organisms.

Knowledge and/or skills

- ◆ Genetic variation in bacteria: conjugation, transformation
- ◆ Genetic variation in viruses: mutations, reassortment
- ◆ Genetic variation in protozoa: mutations, antigenic variation
- ◆ Genetic variation in fungi: mutations, random assortment, cross over

Outcome 2

Explain aspects of clinical microbiology and infection.

Knowledge and/or skills

- ◆ Aetiology and epidemiology of microbial infection
- ◆ Isolation of pathogens from clinical samples
- ◆ Use of staining methods and microscopy in identification of clinical isolates
- ◆ Use of biochemical tests in identification of clinical isolates
- ◆ Drug susceptibility testing in identification and treatment of clinical isolates
- ◆ Immunoassays in the detection of pathogens
- ◆ Nucleic acid techniques in the detection of pathogens
- ◆ Biotechnological treatments in microbial infection

Outcome 3

Explain aspects of cellular microbiology.

Knowledge and/or skills

- ◆ Biofilm formation and their role in virulence
- ◆ Quorum sensing and its role in virulence
- ◆ Production of toxins and their role in virulence
- ◆ Mechanisms by which micro-organisms can aid attachment to their host cells
- ◆ Mechanisms by which micro-organisms can evade host cells
- ◆ Mechanism of action of antibiotics and antivirals used in the treatment of disease

Higher National Unit Specification: Statement of standards (cont)

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Outcome 4

Perform practical experiments related to microbiology.

Knowledge and/or skills

- ◆ Microbiology experiments
- ◆ Working safely, within current health and safety regulations
- ◆ Consistent and accurate results
- ◆ Recording observations and results
- ◆ Evaluation skills
- ◆ Result analysis and conclusions

Evidence requirements for this unit

Written and/or oral recorded evidence for Outcomes 1–3 should be assessed using a holistic closed-book assessment under supervised conditions. The assessment will use a sampling approach to the knowledge and/or skills as detailed below. It is recommended that the assessment be completed within two hours.

Written and/or oral recorded evidence for Outcome 4 should be assessed by production of a full laboratory report, completion of an appropriate pro forma or a laboratory diary entry. An assessor's observation checklist could be used to record performance evidence of practical experiments.

Outcome 1

The assessment will sample three of the four knowledge and/or skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (resit) assessment.

Where an item is sampled, a learner's response will be judged satisfactory where the evidence shows that the learner can:

- ◆ Explain the process of genetic recombination in bacteria by means of conjugation and transformation
- ◆ Explain the role of mutations and reassortment in increasing variation in viruses
- ◆ Explain the role of mutations and antigenic variation in increasing variation in protozoa
- ◆ Explain the role of mutations and random assortment in increasing variation in fungi; explain the role of cross over in achieving variation in fungi

Higher National Unit Specification: Statement of standards (cont)

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Outcome 2

The assessment will sample five of the eight knowledge and/or skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (resit) assessment.

Where an item is sampled, a learner's response will be judged satisfactory where the evidence shows that the learner can:

- ◆ Describe micro-organisms responsible for human disease and occurrence, spread and methods used in control of the disease
- ◆ Explain a method used in the isolation of pathogens from clinical samples
- ◆ Explain the use of staining methods and microscopy in the identification of clinical isolates
- ◆ Explain the use of biochemical tests in the identification of clinical isolates
- ◆ Explain the use of drug susceptibility testing in the identification and treatment of clinical isolates
- ◆ Explain the use of current immunoassay methods in the detection of pathogens
- ◆ Explain a method using nucleic acid techniques in the detection of pathogens
- ◆ Explain a method of biotechnological treatment used to treat microbial infection

Outcome 3

The assessment will sample four of the six knowledge and/or skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (resit) assessment.

Where an item is sampled, a learner's response will be judged satisfactory where the evidence shows that the learner can:

- ◆ Explain the formation and role of biofilms and their role in virulence
- ◆ Explain the process of quorum sensing and its role in virulence
- ◆ Explain the production of toxins and their role in virulence
- ◆ Explain mechanisms by which micro-organisms can aid attachment to their host cells
- ◆ Explain mechanisms by which micro-organisms can evade host cells
- ◆ Explain the mechanism of action of antibiotics and antivirals used in the treatment of disease

Outcome 4

Learners will perform a minimum of four practical experiments, the content of which will be related to Outcomes 1–3. A learner's response will be judged satisfactory where the evidence shows that the learner can achieve all of the following:

- ◆ Follow instructions to perform experiments related to microbiology
- ◆ Work in a safe manner regarding current health and safety regulations
- ◆ Achieve consistent and accurate results
- ◆ Record experimental observations and results clearly and accurately
- ◆ Evaluate validity of results in terms of sources of and values of experimental errors
- ◆ Analyse results correctly and state valid conclusions

Higher National Unit Specification: Statement of standards (cont)

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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.

Learners must report two of the four practical experiments by production of a full laboratory report. Learners may report the remaining practical experiments by production of a full laboratory report, completion of an appropriate pro forma or a laboratory diary entry. Where a pro forma approach is deployed, the pro forma will not present information or assistance to the learners on how to correctly perform calculations, analyse experimental results or experimental errors. Learners will be expected to perform such activities independently on the basis of the experimental data. Where a laboratory diary approach is deployed, the laboratory diary must meet all of the requirements of a pro forma (in particular an evaluation of experimental errors), as set out in the understanding standards materials.

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 laboratory report, pro forma or laboratory diary does not meet the required standard, then the learner will be given a single opportunity to redraft. If the required standard is still not attained, then an alternative practical experiment will be set.



Higher National Unit Support Notes

Unit title: Microbiological Techniques (SCQF level 8)

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 80 hours.

Guidance on the content and context for this unit

This unit is intended as part of the framework for HND Applied Biological Sciences but may be suitable for inclusion in other HN Science awards. It is designed to develop the theoretical and practical aspects of microbiological techniques introduced in the HN Unit H92G 34 *Microbiology: Theory and Laboratory Skills* which are currently used in the scientific community.

Outcome 1 — Explain mechanisms of variation in micro-organisms

- ◆ Genetic recombination in bacteria; conjugation to include natural competency, theoretical conjugation and the differences in conjugation with high frequency strains. Transformation to include bacterial competency, role of plasmids, natural transformation and artificially induced transformation in the laboratory
- ◆ Genetic variation in viruses to include the role of mutations and reassortment including antigenic drift and antigenic shift in eg, influenza virus
- ◆ Genetic variation in protozoa to include the role of mutations in increasing variation in protozoa, and the role of antigenic variation in pathogenic protozoa (eg, Trypanosomes)
- ◆ Genetic variation in fungi to include the role of mutations, random assortment and cross over in increasing variation eg, for resistance to antifungal drugs, role of asexual and sexual reproduction in increasing variation

Outcome 2 — Explain aspects of clinical microbiology and infection

- ◆ Aetiology and epidemiology to include named examples of micro-organisms responsible for human disease and the occurrence, spread and methods used to control the disease
- ◆ Isolation of pathogens from clinical samples to include general purpose, selective and differential growth medium
- ◆ Use of staining methods (eg, Gram's stain) and microscopy in the identification of clinical isolates
- ◆ Biochemical tests to include coagulase testing, indole testing, nitrate reductions and multi-test systems
- ◆ Drug susceptibility testing to include antibiotic susceptibility and the disc diffusion method
- ◆ Immunoassays to include antibody titres, agglutination, and enzyme immunoassays
- ◆ Nucleic acid techniques to include nucleic acid hybridization (probes, primers, assays) and nucleic acid amplification (reverse transcriptase PCR and real time PCR)
- ◆ Biotechnological treatments to include traditional and novel methods of vaccine production and phage therapy

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Outcome 3 — Explain aspects of cellular microbiology

- ◆ Biofilm formation to include the role of pheromones and their contribution to virulence
- ◆ Quorum sensing to include the role of pheromones and the potential of blocking pheromone production in the manipulation and treatment of bacterial infection
- ◆ Toxin production to include lipopolysaccharide (LPS), cholera toxin, botulinum toxin, and tetanus toxin AB and their role in virulence
- ◆ Attachment to include adhesins, fimbriae, flagella and co-receptor molecules
- ◆ Evasion of host cells to include avoidance of phagocytosis, manipulation of host cell organelles, regulation of host cell cycle and toxin production
- ◆ Antibiotics/antivirals used in the treatment of disease to include acyclovir, tetracycline and penicillin

Outcome 4 — Perform practical experiments related to microbiology

Guidance on suitable practical experiments for assessment purposes is given elsewhere in this document. However, it is envisaged that learners will also participate in a range of other practical experiments which will both develop their laboratory skills and support the theory covered in Outcomes 1–3.

In carrying out such activities, learners should follow Good Laboratory Practice (GLP) and carry out or be familiar with the risk and Control of Substances Hazardous to Health (COSHH) assessments on all procedures undertaken. Opportunities should be taken to develop awareness of the sources of experimental error and of the accuracy of measurements, with quantification of errors where possible.

Guidance on approaches to delivery of this unit

There is no particular order in which Outcomes 1–3 would be best delivered. It is envisaged that laboratory work and demonstrations will feature across the delivery of each of the outcomes, and that the assessed practical experiments for Outcome 4 will be undertaken in a similar timeframe to the underpinning theory.

Outcome 1 should cover recombination in bacteria, viruses, protozoa and fungi. The opportunity for laboratory practicals to enhance learner experience is advantageous as part of Outcome 1 and it is encouraged that learners utilise transformation and conjugation techniques. Use of video footage and group work should enhance the learners understanding in this particular outcome. Whilst it is not mandatory content, during the delivery of Outcome 1 it would be advantageous for lecturers to discuss other bacterial reproduction methods including transposition, transduction and phage induced variation.

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Outcome 2 is intended to have a more practical based approach. This outcome should build on previous knowledge obtained at SCQF level 7. Learners should be encouraged to undertake research work, further developing IT skills, as part of this outcome, eg, the production of health advice leaflets. The remainder of Outcome 2 relies on the understanding of current scientific approaches in microbiology. It is important the learner gains as much practical experience in these techniques as possible, where resources allow. If practical implementation of all these techniques is not possible the use of virtual laboratories or laboratory visits may prove useful.

It is envisaged that Outcome 3, by its nature, will offer fewer, if any, opportunities for practical work; antibiotic disc diffusion method on susceptibility of micro-organisms would therefore be encouraged here and would allow integration of Outcome 2, Outcome 3 and Outcome 4. Video footage may be beneficial in enhancing the learning experience. Learners should also be encouraged to research this area in order to enhance IT skills.

It should be noted that cross over of information from other units at this level is expected and should be encouraged.

It is envisaged that Outcome 4 will be delivered alongside the theoretical based Outcomes 1–3. A range of practical experiments could be utilised to both support understanding of the underlying theory and to prepare learners for undertaking the assessed practical experiments.

Guidance on approaches to assessment of this unit

Outcomes 1–3 could be assessed by a single holistic closed-book assessment with an appropriate cut-off score that covers the sampling requirements as detailed in the evidence requirements. Assessment should be carried out in supervised conditions, and it is recommended that the assessment be completed within 2 hours.

Where evidence of Outcomes 1–3 is assessed by sampling, the whole of the content listed in the knowledge and/or skills must be taught and available for assessment. Learners should not know in advance the items on which they will be assessed, and different items should be sampled on each assessment occasion. Any items not sampled in the first assessment must be included in the alternative (resit) assessment.

In Outcome 4 learners are required to undertake four assessed practical experiments, the content of which will be related to Outcomes 1–3. 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.

Suitable practical experiments for Outcome 1 are:

- ◆ Transformation of *E-coli*
- ◆ Ligation and transformation of T4 ligase
- ◆ Conjugation in *E-coli*

Higher National Unit Support Notes (cont)

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Suitable practical experiments for Outcome 2 are:

- ◆ Coagulase testing for the presence of *staphylococcus* isolates
- ◆ Indole testing for the presence of *E-coli* isolates
- ◆ Nitrate reductions for the presence of *pseudomonas* isolates
- ◆ Selective media in the identification of pathogens
- ◆ Antibiotic gels and disc diffusion method to test antibiotic susceptibility using broad spectrum and narrow spectrum antibiotics
- ◆ Strep A–F agglutination test (identification of cause of infection)
- ◆ Immunoblot for the detection of protein X
- ◆ ELISA for tracking disease outbreak
- ◆ Antigen detection ELISA
- ◆ ELISA antibody test

Suitable practical experiments for Outcome 3 are:

- ◆ Antibiotic gels and disc diffusion method to test antibiotic susceptibility with a focus on Mechanism of Action (MOA) of antibiotic in use

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.

An exemplar instrument of assessment with marking guidelines has been produced to indicate the national standard of achievement at SCQF level 8.

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.

Higher National Unit Support Notes (cont)

Unit title: Microbiological Techniques (SCQF level 8)

Opportunities for developing Core and other essential skills

The delivery and assessment of this unit will provide learners with the opportunity to develop the Core Skills of *Problem Solving* at SCQF level 6, *Numeracy* at SCQF level 5 and *Information and Communication Technology (ICT)* at SCQF level 4.

***Problem Solving* — Reviewing and Evaluating at SCQF level 6**

Following assessed practical experiments learners will be required to review and evaluate the effectiveness of the exercise with a thorough interpretation of random and systematic sources of error. Learners will be required to reach sound conclusions on the basis of the data collected and the inherent errors.

***Numeracy* — Using Number at SCQF level 5**

Learners will be required to decide on the steps and operations to solve complex problems, carrying out sustained and complex calculations, eg, laboratory calculations.

***Information and Communication Technology* — Providing/Creating Information (ICT) at SCQF level 4**

Learners will make effective and appropriate use of ICT packages to produce laboratory reports in an appropriate format. Packages used will likely include word processing, spreadsheets, and graph drawing software. Learners will also be required to utilise internet search engines to source information on research topics.

Sustainability can be embedded in delivery of the unit in a variety of ways. For example, by encouraging minimum usage, correct disposal procedures and possible recycling (eg, of ethanol) during practical experiments.

The Critical Thinking component of Problem Solving at SCQF level 6 is embedded in this unit. When a learner achieves the unit, their Core Skills profile will also be updated to include this component

History of changes to unit

Version	Description of change	Date
02	Core Skills Component Critical Thinking at SCQF level 6 embedded.	16/08/19

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General information for learners

Unit title: Microbiological Techniques (SCQF level 8)

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 2 credit unit at SCQF level 8, which you are likely to be studying as part of the first year of an HNC/HND Science programme. Before progressing to this unit it would be advisable to have completed the HN Unit H92G 34 *Microbiology: Theory and Laboratory Skills*, where you will have learned underpinning aspects of microbiology and developed your practical skills.

On completion of the unit you should be able to:

- 1 Explain mechanisms of variation in micro-organisms.
- 2 Explain aspects of clinical microbiology and infection.
- 3 Explain aspects of cellular microbiology.
- 4 Perform practical experiments related to microbiology.

Outcome 1

In this outcome you will study methods used by micro-organisms and how this allows them to achieve variation within their particular species. It will help you understand the need for variation within a species and the types of genes that can successfully be exchanged. It will also allow you to understand the manipulation of these natural processes for scientific gain and understanding, as well as helping you understand the limitations of each method discussed.

Outcome 2

In this outcome you will identify micro-organisms that cause human disease, the occurrence of the disease as well as the spread of disease. You will also study different means of controlling the spread of the diseases in question. You will then study different laboratory methods of identifying the pathogens responsible for causing disease. You will also learn about the limitations of each test as well as understanding the inter-relationships between them, and you will learn about the manipulation of biological processes for scientific gain.

Outcome 3

In this outcome you will learn about signalling mechanisms between micro-organisms and mechanisms employed by micro-organisms as a means of communication. The mechanisms to aid in host cell attachment will also be discussed. You will study the defensive mechanisms engaged by micro-organisms including the production of toxins in order to evade host cell mechanisms of destruction.

Outcome 4

In this outcome you will undertake practical experiments, based on the content of Outcomes 1–3.

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During this practical work, you will also be expected to develop good laboratory practices as well as improve your skills of manipulation, observation and measurement. You will also be encouraged to develop safe working practices and to strive constantly to improve the accuracy and reliability of your results. The reporting and analysis of experimental data is an important aspect of the practical sessions.

Assessment

For Outcomes 1–3 you will take a closed-book, end of unit assessment.

Outcome 4 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 either in full laboratory reports, completion of pro forma reports or laboratory diary entries. You must produce full laboratory reports for at least two practical experiments.

Core Skills

You will have opportunities to develop the Core Skills of *Problem Solving* at SCQF level 6, *Numeracy* at SCQF level 5 and *Information and Communication Technology (ICT)* at SCQF level 4 within this unit.

The Critical Thinking component of Problem Solving at SCQF level 6 is embedded in this unit. When a learner achieves the unit, their Core Skills profile will also be updated to include this component