

## **National Unit Specification: general information**

**UNIT** Microbiology (Higher)

**NUMBER** DF5H 12

**COURSE** Biotechnology (Higher)

### **SUMMARY**

This unit seeks to develop knowledge and understanding, problem solving and practical abilities in the context of the structure of micro-organisms of biotechnological significance, microbial metabolism, genetic engineering and infection and immunity. This is a component unit of Higher Biotechnology.

### **OUTCOMES**

- 1 Demonstrate knowledge and understanding related to microbiology.
- 2 Solve problems related to microbiology.
- 3 Solve problems related to Higher Biotechnology.

### **RECOMMENDED ENTRY**

While entry is at the discretion of the centre, candidates would normally be expected to have attained one of the following:

- Intermediate 2 Biotechnology
- Standard Grade Biology at Credit level
- Intermediate 2 Biology.

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### **Administrative Information**

**Superclass:** RH

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## **National Unit Specification: general information (cont)**

**UNIT**      Microbiology (Higher)

### **CREDIT VALUE**

1 credit at Higher (6 SCQF credit points at SCQF 6\*)

*\*SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.*

### **CORE SKILLS**

Core skills for this qualification remain subject to confirmation and details will be available at a later date.

Additional information about core skills is published in the *Catalogue of Core Skills in National Qualifications* (SQA, 2001).

## **National Unit Specification: statement of standards**

### **UNIT      Microbiology (Higher)**

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 the Scottish Qualifications Authority.

#### **OUTCOME 1**

Demonstrate knowledge and understanding related to microbiology.

##### **Performance criteria**

- (a) Micro-organisms are described correctly in relation to their structure and uses.
- (b) Microbial metabolism is described correctly in terms of energy release, patterns of growth and copying and translating genes.
- (c) Genetic engineering is described correctly in relation to the use of genes.
- (d) Immunity is described correctly in relation to infection.

##### **Evidence requirements**

Evidence of an appropriate level of achievement must be generated from a closed-book test with items covering all the above performance criteria.

#### **OUTCOME 2**

Solve problems related to microbiology.

##### **Performance criteria**

- (a) Relevant information is selected and presented in an appropriate format.
- (b) Information is accurately processed using calculations where appropriate.
- (c) Conclusions drawn are valid and explanations given are supported by evidence.
- (d) Experimental procedures are planned, designed and evaluated appropriately.
- (e) Predictions and generalisations made are based on available evidence.

##### **Evidence requirements**

Evidence of an appropriate level of achievement must be generated from a closed-book test with items covering all the above performance criteria, with problems in the context of the structure of micro-organisms, microbial metabolism, genetic engineering or infection and immunity.

## **National Unit Specification: statement of standards (cont)**

### **UNIT      Microbiology (Higher)**

#### **OUTCOME 3**

Solve problems related to Higher Biotechnology.

##### **Performance criteria**

- (a) The problem to be solved is identified.
- (b) Resources required to solve the problem are identified and obtained.
- (c) Procedures appropriate to solving the problem are planned and designed.
- (d) The planned procedures are carried out.
- (e) The problem solving procedure is evaluated.

##### **Evidence requirements**

A report of one problem solving activity covering the above performance criteria in relation to the content and notes specified for Higher Biotechnology. The report must be the individual work of the candidate. Depending on the activity, the problem solving may be groupwork.

## National Unit Specification: support notes

### UNIT Microbiology (Higher)

This part of the unit specification is offered as guidance. The support notes 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 CONTENT AND CONTEXT FOR THIS UNIT

#### *Outcome 1*

##### **a) Structure of micro-organisms**

- i Prokaryotes and eukaryotes.
- ii Bacteria.  
Structure and function.  
Shape.  
Gram positive and Gram negative bacteria.  
Uses.
- ii Fungi.  
Structure.  
Reproduction.  
Uses.
- iii Viruses.  
The nature of viruses and their invasion of cells.  
Alteration of cell instructions to produce more viruses.  
Types.  
Uses.

##### **b) Microbial metabolism**

- 1 Energy release  
The role and production of adenosine triphosphate (ATP):
  - i ATP as a means of transferring chemical energy.  
Regeneration of ATP from ADP and inorganic phosphate.
  - ii Glycolysis: the breakdown of glucose to pyruvic acid with a net production of ATP in the cytoplasm.
  - iii Krebs (citric acid, tricarboxylic acid) cycle and cytochrome system. The location of these reactions within the cristae and matrix of the mitochondrion in eukaryotes.  
Relationship of folding of inner membrane to activity of mitochondrion.  
The production of ATP, carbon dioxide, hydrogen and reduced co-enzyme.
  - iv The distinction between anaerobic and aerobic phases of respiration with reference to location, level of ATP produced and final metabolic products.
  - v Fermentation.
- 2 Patterns of growth
  - i Factors affecting growth.
  - ii The bacterial growth curve in liquid media.

## National Unit Specification: support notes (cont)

### UNIT Microbiology (Higher)

- 3 Copying and translating genes
  - i DNA structure.
  - ii Single circular chromosome in prokaryotes.
  - iii Plasmids.
  - iv The structure of protein.
  - v RNA structure and function in protein synthesis.  
The role of cellular organelles in protein synthesis.
  - vi An introduction to the Jacob-Monod hypothesis of gene action in bacteria.

#### c) Genetic engineering

- i Extraction and preparation of DNA sequences.  
Purification of DNA.  
Use of restriction endonucleases in gene sequences.  
Separation of DNA fragments by gel electrophoresis and use of probes.  
cDNA production.
- ii Transformation and cloning.  
Advantages and disadvantages of using the bacterium *E. coli* and the yeast *S. cerevisiae* as recipients for foreign DNA.  
Cloning vectors.  
Transformation.  
Cloning.

#### d) Infection and immunity

- i Micro-organisms as pathogens.
- ii Production of antibodies and the role of blood cells.  
Cell-mediated response by T-lymphocytes.  
Production of humoral antibodies by B-lymphocytes.
- iii The function of macrophages.  
Phagocytosis and the function of lysosomes.
- iv Immunity.  
Innate immunity.  
Acquired immunity: natural and artificial.  
Active and passive immunity.

Further detail is given in the supplementary notes in the course content section of the course specification.

## National Unit Specification: support notes (cont)

### UNIT Microbiology (Higher)

#### Outcome 2

Examples of learning activities which provide suitable contexts for the development of problem solving skills include:

- identify micro-organisms using keys
- identify a range of bacteria from prepared slides and flowcharts of identifying characteristics
- analyse data on different fermentation processes
- analyse data on bacterial population count
- obtain information from a variety of sources on the nature of DNA and RNA and their roles in protein synthesis
- analyse data on the restriction and electrophoresis of DNA
- produce a flow diagram to show the production process using *E. coli* and *S. cerevisiae*
- obtain and present information on the way the HIV 1 (Human Immunodeficiency Virus) disrupts the mechanisms of the immune system
- analyse data on the success of vaccination programmes in the global eradication of specified diseases.

#### Outcome 3

Suitable experiments in the context of this unit include:

- identify a range of bacteria using reaction to Gram stain and morphology
- design and carry out an investigation to show the activity of dehydrogenase enzymes in yeast
- demonstrate fermentation and/or lactic acid production in souring milk
- temperature/pH/glucose concentration on the growth of a named micro-organism
- carry out an investigation into the effects of  $\beta$ -galactosidase enzyme on lactose in milk
- carry out an investigation into antibody/antigen reaction using animal sera and antisera.

### GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

Details of suitable approaches are provided in the course specification.

### GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

It is recommended that a holistic approach is taken to assessment, eg Outcomes 1 and 2 could be assessed by an integrated end of unit test with questions covering all the performance criteria for knowledge and understanding and problem solving. The National Assessment Bank will provide advice on suitable approaches.

## **National Unit Specification: support notes (cont)**

### **UNIT      Microbiology (Higher)**

#### ***Outcome 2***

Test items should be constructed to allow candidates to generate evidence relating to the performance criteria as follows:

- a) Selecting and presenting information:
  - sources of information to include: texts, tables, charts, graphs and diagrams
  - formats of presentation to include: written summaries, extended writing, tables and graphs.
- b) Calculations to include: percentages, averages, ratios. Significant figures and units should be used appropriately.
- c) Conclusions drawn should include some justification.
- d) Candidates could plan and design procedures to test given hypotheses or to illustrate particular effects. This could include identification of variables, controls and measurements or observations required. The evaluation of given experimental procedures may include situations which are unfamiliar to candidates and could test the candidates' ability to comment on the purpose of approach or the suitability of given experimental procedures. Candidates could comment on the limitations of the set-up, apparatus, suggested measurements or observations, limitations of equipment, appropriateness of controls, sources of error and possible improvements.
- e) Candidates could make predictions and generalisations from given experimental results or, given situations, predict what the results might be.

#### ***Outcome 3***

This involves the submission of one report of a problem solving activity related to Higher Biotechnology.

Candidates are only required to produce one report on a problem solving activity for Higher Biotechnology. This report can be used as evidence for Outcome 3 in 'Microbiology' and for Outcome 2 in 'Biotechnology'.

The 'Outcome 2: Teacher/lecturer guide' is provided to indicate what might be addressed to achieve a specific performance criterion. The relevance of the items will vary according to the problem solving activity being undertaken eg bullet points which refer to variables would not apply in a case study type problem solving activity. The professional judgement of the teacher/lecturer will be important in deciding if a performance criterion has been met for a particular activity.

## National Unit Specification: support notes (cont)

### UNIT Microbiology (Higher)

#### Outcome 2: Teacher/Lecturer guide

All the performance criteria given in the left-hand column must be achieved in order to attain the outcome. The right-hand column gives suggestions which might aid the professional judgement of the assessor.

Performance criteria	Suggestions to aid professional judgement
(a) The problem to be solved is identified.	Main features of the problem are identified.
(b) Resources required to solve the problem are identified and obtained.	Resources might include: <ul style="list-style-type: none"> <li>• sources of information</li> <li>• set procedures</li> <li>• people</li> <li>• equipment/physical resources</li> <li>• materials.</li> </ul>
(c) Procedures appropriate to solving the problem are planned and designed.	The plan might include: <ul style="list-style-type: none"> <li>• what is to be measured/collected</li> <li>• variable altered</li> <li>• variable kept constant</li> <li>• how many readings/measurements/observations/subjects</li> <li>• equipment/resources required</li> <li>• how data will be recorded, analysed and presented.</li> </ul>
(d) The planned procedures are carried out.	This would include a record of the data collected, analysis and presentation of data.  Data should be analysed and presented in tabular, graphical format or as a scatter diagram or equivalent as appropriate: <ul style="list-style-type: none"> <li>• for tabular presentation this must include: suitable headings and units showing averages or other appropriate computations</li> <li>• for graphical presentation this must include: data presented as a histogram, bar chart, connected points, line of best fit as appropriate, with suitable skills and axes labelled with quantities and units and with data correctly plotted.</li> </ul>
(e) The problem solving procedure is evaluated.	The evaluation might include: <ul style="list-style-type: none"> <li>• an assessment of the effectiveness of the procedure including: planning and organising and the outcome of the activity</li> <li>• drawing valid conclusions, which make use of the presented evidence</li> <li>• suggestions for alternative or modified strategies, further work, predictions or generalisations</li> <li>• an assessment/explanation of the relevance of the results.</li> </ul>

## **National Unit Specification: support notes (cont)**

### **UNIT      Microbiology (Higher)**

The bullet points under each performance criterion give an indication of what should be addressed to achieve a pass. The relevance of the bullet points will vary according to the experiment. These bullet points are intended as helpful guidance. The decision of pass or fail is to be made by the professional judgement of the presenting centre (subject to moderation) against the performance criteria. It is appropriate to support candidates in producing a report to meet the performance criteria. Re-drafting of a report after necessary supportive criticism is to be encouraged both as part of the learning and teaching process and to produce evidence for assessment. Redrafting and resubmission is only required if the entire report does not need to be rewritten.

#### **Conditions required to complete the report**

Teachers and lecturers may wish candidates to write up reports under their direct supervision so that they can provide appropriate advice and support. However, they may feel confident that any redrafting required need not be undertaken under such close supervision as it will be evident in the candidates' response that it is his or her unaided work. Under such circumstances it would be acceptable for such redrafting to take place outwith class time.

#### **Use of IT**

Candidates may, if they wish, present their reports in a word-processed format. Candidates may use Excel (or any other suitable data analysis software) when tackling Outcome 3. However, candidates must not be given a spreadsheet with pre-prepared column headings nor formulae, as they are being assessed on their ability to enter quantities and units into a table and to make decisions about appropriate scales and labels on graph axes. The use of clip art or images captured by digital camera may also be used in recording details of experimental methods.

#### **Transfer of evidence**

Candidates may transfer evidence for Outcome 3 from one level to the one below provided the experiments are in the context of the course concerned.

Candidates, who are repeating a course, may carry forward evidence of an appropriate standard, generated in a previous year.

#### **SPECIAL NEEDS**

This unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative outcomes for units. For information on these, please refer to the SQA document *Guidance on Special Assessment Arrangements* (SQA, 2001).