SCOTTISH QUALIFICATIONS AUTHORITY

BIOTECHNOLOGY
Intermediate 2

Fifth Edition – published March 2004

NOTE OF CHANGES TO ARRANGEMENTS

FIFTH EDITION PUBLISHED

COURSE TITLE: Biotechnology (Intermediate 2)

COURSE NUMBER: C008 11

National Course Specification

Course Details

No Change

Assessment: section inserted which clarifies details of Instruments of Internal Assessments.

National Unit Specification:

DF5F 11 The Biology of Micro-organisms

Statement of Standards:

Outcome 3: outcome, performance criteria and evidence requirements have been amended.

Support Notes

Guidance on Approaches to Assessment for the units includes revised guidance on Outcome 3.

NOTE OF CHANGES TO ARRANGEMENTS (cont)

COURSE TITLE: Biotechnology (Intermediate 2)

COURSE NUMBER: C008 11

D039 11 Working with Micro-organisms

Statement of Standards

No change.

Support Notes

No change.

DF5G 11 Biotechnology Processes

Statement of standards

Outcome 2: outcome and evidence requirements have been amended.

Support Notes

Guidance on Approaches to Assessment for this unit includes revised guidance on Outcome 2.

National Course Specification

BIOTECHNOLOGY (INTERMEDIATE 2)

COURSE NUMBER C008 11

COURSE STRUCTURE

The course has three 40 hour units. The units cover the following content areas:

DF5F 11 ***The Biology of Micro-organisms (Int 2)*** ***1 credit (40 hours)***

- *Structure and Reproduction of Micro-organisms*
- *Biochemistry in Micro-organisms*
- *Ecology of Micro-organisms*

D039 11 ***Working with Micro-organisms (Int 2)*** ***1 credit (40 hours)***

- *Microbiological Procedures*
- *Microscopy*

DF5G 11 ***Biotechnology Processes (Int 2)*** ***1 credit (40 hours)***

- *Agriculture*
- *Pharmaceuticals*
- *Food*
- *Energy*
- *Biodegradation*

In common with all courses, this course includes a further 40 hours over and above the 120 hours for the component units. This may be used for induction, extending the range of learning and teaching approaches, support, consolidation, integration of learning and preparation for external assessment. This time is an important element of the course and advice on its use is included in the course details.

Administrative Information

Superclass: RH

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National Course Specification: (cont)

COURSE Biotechnology (Intermediate 2)

RECOMMENDED ENTRY

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

- Standard Grade Biology
- Intermediate 1 Biology.

Previous biology experience is not an absolute requirement and the course is therefore also suitable for those wishing to study biotechnology with a background in other sciences. The course would also be suitable for studying in tandem with Intermediate 2 Biology or Higher Biology or Higher Human Biology.

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).

CREDIT VALUE

The Intermediate 2 Biotechnology Course is allocated 24 SCQF Credit Points at SCQF level 5*

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

National Course Specification: course details

COURSE Biotechnology (Intermediate 2)

RATIONALE

Biotechnology is the use of micro-organisms, cells, and cell products in manufacturing and service industries. The products and processes of biotechnology have led to advances in many areas of medicine, agriculture, commerce and the service industries. Biotechnology is at the forefront of present day applied science and has the potential to solve some of the greatest problems facing the modern world, such as the energy crisis, food shortage, pollution and the threat of disease.

The course provides an integrated study of the biology, practical skills and production methods relevant to biotechnology. In particular, the course develops an understanding of the way microbiology is applied in industrial and commercial settings. Although the course has been designed as free standing it will be particularly appropriate in a programme of study which includes the study of biology or other sciences. The study of Intermediate 2 Biotechnology contributes to the candidate's general and vocational education through the acquisition of competence in handling micro-organisms relevant to a range of work environments, and knowledge of the application of biological science in the workplace.

The course provides opportunities for candidates to acquire:

- knowledge and understanding of biological concepts, facts, ideas and techniques and the role of biotechnology in society and industry
- skills in problem solving, particularly in practical contexts
- competence in the techniques of handling and studying micro-organisms
- practical skills associated with biotechnology
- an awareness of the ways in which biotechnology can affect the well-being of themselves and others, and the quality of their environment.

The content reflects the importance of underlying biological principles and processes in order to achieve a basic understanding of the biology of micro-organisms. As a result, it should be possible to embark on this course successfully with a limited experience of biology.

National Course Specification: course details (cont)

COURSE Biotechnology (Intermediate 2)

COURSE CONTENT

The Intermediate 2 Biotechnology course comprises three units, each of which has a short introduction indicating the purpose of the unit. These units need not be taught sequentially. Centres may wish to teach the course units in an integrated fashion so that knowledge and skills developed can be applied in the context of another unit. The course further develops the Standard Grade elements and Intermediate 1 level outcomes of knowledge and understanding, problem solving and practical abilities.

Knowledge and understanding

Candidates should develop the ability to recall and understand the facts and principles detailed in the course content statements and supplementary notes in the following tables.

Problem solving

Problem solving skills should be developed so that candidates can generally:

- identify problems
- select relevant information from texts, tables, charts, keys, graphs and diagrams
- present information appropriately in a variety of forms, including written summaries, extended writing, tables and graphs
- process information accurately using calculations where appropriate
- plan and design problem solving procedures
- implement planned problem solving procedures
- evaluate problem solving procedures
- plan, design and evaluate experimental procedures
- draw valid conclusions and give explanations supported by evidence
- make predictions and generalisations based on available evidence.

Practical abilities

Practical work is essential in providing the contexts for the development of scientific problem solving skills. Practical work is necessary to underpin theoretical work and to develop skills. It fosters familiarity with apparatus, equipment and how it works as a useful preparation for further study or employment. As a result of engaging in practical work candidates can generally:

- carry out techniques related to microbiology
- describe experimental procedures accurately
- record relevant measurements and observations in appropriate formats
- analyse and present experimental information in appropriate formats
- draw valid conclusions
- evaluate experimental procedures with supporting argument.

The following tables contain the content and suggested learning activities through which knowledge and understanding, problem solving and practical abilities are to be developed. The content statements and supplementary notes, which provide amplification and give an indication of depth of treatment, are required for the purposes of assessment.

National Course Specification: course details (cont)

Unit 1: The Biology of Micro-organisms (Intermediate 2)

Introduction

This unit is designed to provide a basic understanding of the biology of micro-organisms to provide the underpinning knowledge and understanding for the other component units of the course. The approach to the study of biology as it applies to micro-organisms also allows an understanding of the major biological principles of biochemistry and ecology to be developed.

CONTENT	NOTES	LEARNING ACTIVITIES
a) Structure and reproduction of micro-organisms		
i Bacteria.		
Cellular structure and function.	Structure: lack of an organised nucleus; presence of circular DNA; plasmid, plasma membrane; cell wall; cytoplasm; external capsule; flagella; spores. Functions of circular DNA; plasmid; plasma membrane; cell wall; cytoplasm; external capsule; flagella; spores.	Observe bacteria to look at characteristic shapes, capsules, spores and evidence of reproduction.
Shape	Characteristic shapes of bacteria: round (cocci); rods (bacilli) and spiral (spirilla).	
Reproduction	Asexual reproduction by binary fission leading to rapid increase in numbers of identical bacteria. Exchange of genetic material with and without conjugation leading to variation.	
ii Viruses.		
Structure	Non cellular structure of viruses. DNA/RNA core surrounded by protein coat.	Examine photomicrographs of viruses.

National Course Specification: course details (cont)

Unit 1: The Biology of Micro-organisms (Intermediate 2)

CONTENT	NOTES	LEARNING ACTIVITIES
Replication.	Replication of viruses to include attachment of virus to host (eg bacteria, animal cell, plant cell); injection of viral DNA into host cell; viral DNA controls production and release of viruses.	
iii Fungi.		
Cellular structure of fungi as exemplified by yeast and *Mucor*.	Presence and functions of nucleus; cytoplasm; plasma membrane; vacuole; cell wall.	Microscopic examination of yeast using vital stains.
Reproduction in yeast and *Mucor*.	Asexual reproduction by budding in yeast.	Examine *Mucor* culture to observe spore formation.
	Asexual reproduction in *Mucor* by sporangia arising from the mycelium.	
	Sexual reproduction in *Mucor* by fusion of gametes to produce a zygospore.	Grow + and – strains of *Mucor* to show sexual reproduction.
iv Algae.		
Cellular structure and function in unicellular algae as exemplified by *Chlorella*.	Presence and functions of nucleus; cytoplasm; plasma membrane; chloroplast; starch granule; cell wall.	
Reproduction.	Asexual reproduction by binary fission in algae.	Microscopic examination of *Chlorella*.
v Protozoa.		
Cellular structure and function in protozoa.	Presence and functions of nucleus; cytoplasm; plasma membrane; contractile vacuole; food vacuole.	Examine cultures of, for example, *Paramecium, Amoeba* or *Euglena*.
Reproduction.	Asexual reproduction by binary fission.	

National Course Specification: course details (cont)

Unit 1: The Biology of Micro-organisms (Intermediate 2)

CONTENT	NOTES	LEARNING ACTIVITIES
b) Biochemistry in micro-organisms		
i Photosynthesis.	Summary equation for the photosynthetic process. Photosynthesis considered as a process with raw materials, products and rate limiting factors. Production of biomass and oxygen by photosynthesis. The major contribution of micro-organisms in the oceans to global photosynthesis.	Investigate the growth and/or productivity of a *Chlorella* culture under different light conditions. Investigate the limiting factors of photosynthesis using a *Chlorella* culture.
ii Mineral nutrition.	Minerals are essential for building cell components and for growth. The requirement for minerals in growth media. Minerals as growth limiting factors in cultures of micro-organisms.	Investigate the effects of mineral deficiency in *Chlorella* culture. Investigate the effects of nutrient enrichment on the growth of yeast cultures.
iii Enzymes.	Enzymes as protein catalysts. Intracellular and extracellular enzymes. Substrate specificity. Effect of temperature and pH on enzyme activity, including optimal conditions and denaturation. Importance of enzymes in industry, for example the breakdown of starch into sugars by amylase in food processing and the use of lactase in the ice-cream industry.	Carry out an assay of extracellular enzyme activity, eg Amylase activity of *B. subtilis*. Compare the effects of freezing milk products in the absence and presence of the enzyme lactase.
iv Respiration.	Cell respiration as a provider of biochemical energy. Summary equations for aerobic and anaerobic respiration. Ethanol and carbon dioxide or lactic acid as products of anaerobic respiration. Comparison of energy yields of aerobic and anaerobic respiration. Aerobic, facultatively anaerobic and obligately anaerobic organisms.	Test for end products of yeast and *Lactobacilli* fermentations.

National Course Specification: course details (cont)

Unit 1: The Biology of Micro-organisms (Intermediate 2)

CONTENT	NOTES	LEARNING ACTIVITIES
v Biochemical synthesis.	Conversion of glucose into complex carbohydrates (starch, cellulose and chitin) by enzyme synthesis. Amino acids are synthesised from nitrogen and carbon sources. Amino acids as the building blocks of proteins. Other compounds synthesised by micro-organisms for example lipids, vitamins, citric acid, vinegar (acetic acid) and antibiotics.	
	Antibiotics as substances released to inhibit the growth of competing micro-organisms in their natural environments.	Carry out an assay for antibiotic produced by *Penicillium*.
c) Ecology of Micro-organisms		
i Nutrition.		
Saprophytic nutrition.	Saprophytic nutrition characterised by obtaining food from dead or decaying organisms. Production of extracellular enzymes by micro-organisms for external digestion. Absorption of digested products. The importance of saprophytes in the decay process leading to the recycling of carbon and nitrogen.	Observe succession of fruiting bodies on decaying organic matter. Measure temperature changes in compost heap due to thermophilous fungi. Measure the rate of decay of malt extract by the loss of weight in a yeast culture.
Parasitic nutrition.	Parasitic nutrition characterised by obtaining food from a living organism (host). Food obtained by direct absorption or by digestion and absorption.	Satisfy Koch's postulates using, eg *Botrytis cinerea* and *Pelargonium* sp.

National Course Specification: course details (cont)

Unit 1: The Biology of Micro-organisms (Intermediate 2)

CONTENT	NOTES	LEARNING ACTIVITIES
Mycorrhizal associations.	Plant as a source of carbohydrate for fungus, fungus as a source of nitrate from the decomposition of protein. Enhanced ability of fungus and plant to survive in low nutrient habitats.	Examine mychorrhizal associations with and without a microscope.
Root nodules.	*Rhizobium* and the development of root nodules. Plant as a source of carbohydrate, *Rhizobium* as a source of nitrate from nitrogen fixation.	Stain smears of root nodules with carbol fuchsin for *Rhizobium*.
ii Nutrient cycling.		
The carbon cycle.	The cycling of carbon by micro-organisms through energy fixation in photosynthesis and energy release in respiration.	Carry out an assay of cellulase activity in soil using cellulose strips.
The nitrogen cycle.	The cycling of nitrogen by micro-organisms through nitrogen fixation (conversion of nitrogen to ammonia), nitrification (conversion of ammonia to nitrite and then to nitrate) and denitrification (conversion of nitrate to nitrogen). Nitrate as a source of nitrogen for synthesis of amino acids.	

National Course Specification: course details (cont)

Unit 2: Working with Micro-organisms (Intermediate 2)

Introduction

This unit is designed to allow candidates to develop competence in basic microbiological techniques. Sufficient time should be allowed in the unit to practise the necessary skills and routine procedures so that candidates are both confident in handling micro-organisms and develop the necessary competencies.

CONTENT	NOTES	LEARNING ACTIVITIES
a) Microbiological procedures	Emphasis of good laboratory practice as outlined below.	
i Preparation of person.	Hand washing. Protective clothing. Purpose of each of these practices.	
Preparation of work space.	Smooth, non absorbent bench surface. Surface disinfection. Disposal containers. Relatively draught free environment. Updraught from bunsen burner. Transfer chambers and laminar flow cabinets/chambers.	Prepare work space: use Benchkote or similar if necessary, swab surface with a suitable disinfectant, set out materials and equipment in an organised fashion.
ii Aseptic transfer operations and reasons for each stage in the procedure.	Purpose of each of these practices.	
iii Pouring plates.	Melting and setting temperatures of agar. Labelling of plates. Appropriate pouring temperature to avoid condensation. Pouring procedure. Storage of plates. Recognition of plates suitable for use. Flame sterilisation of instruments. Aseptic transfer operations. Labelling of cultures.	Observe use of an autoclave. Bring agar to pouring temperature, label, pour plates, and store. Examine poured plates for contamination.
iv Subculturing micro-organisms.		
Loop transfer.	Procedures for loop transfer of micro-organisms: solid to solid; solid to liquid; liquid to solid; liquid to liquid.	Carry out loop transfers of micro-organisms.

National Course Specification: course details (cont)

Unit 2: Working with Micro-organisms (Intermediate 2)

CONTENT	NOTES	LEARNING ACTIVITIES
Streak plate inoculation.	Procedure for streak plate inoculation, used to obtain isolated colonies. Reason for each step in procedure.	Carry out loop transfers of micro-organisms. Carry out streak plate inoculation.
Transfer of fungal mycelium.	Procedure for transfer of block of agar containing fungal mycelium from plate to plate using a sterile scalpel. Reason for each step involved.	Carry out the transfer block of agar containing fungal mycelium from plate to plate using a sterile scalpel. Use a swab to sample the environment and plate out.
v Separating micro-organisms.	Separate a mixed culture of micro-organisms with visible differences in plate culture.	Streak out a mixed broth culture of two bacteria to produce individual colonies.
b) Microscopy		
i Microscopic examination of micro-organisms.		Examine micro-organisms using the microscope.
Parts and functions of the light microscope.	Eyepiece lens, objective lenses, stage, mirror/light source, focus control.	Examine prepared specimens (including oil immersion if available).
Calculation of total magnification.	No actual measurements needed. Relative sizes of micro-organisms.	
ii Simple staining techniques.		
The processes of fixing and staining leading to the examination of dead micro-organisms.	Fixing as a means of attaching micro-organisms to microscope slide. Staining as a means of improving contrast.	Fix a range of micro-organisms and then use simple stains to show the variety of shapes and structures.

National Course Specification: course details (cont)

Unit 2: Working with Micro-organisms (Intermediate 2)

CONTENT	NOTES	LEARNING ACTIVITIES
Use of vital stains.	Vital stains as a means of improving contrast in living cells.	Stain cultures of fungi and bacteria with, eg methylene blue and carbol fuchsin. Stain smears of yoghurt with nigrosin to visualise bacteria. Stain smears of root nodules with carbol fuchsin for *Rhizobium*.

National Course Specification: course details (cont)

Unit 3: Biotechnology Processes (Intermediate 2)

Introduction

This unit provides an introduction to biotechnology processes.

CONTENT	NOTES	LEARNING ACTIVITIES
a) Agriculture		
i Silage.	Silage as a system of preserving grass or other green crops for winter feeding of livestock. The compression of succulent young grass to exclude oxygen in silos or plastic bags. The resulting fermentation of crop sugars increases temperature and removes oxygen leading to the predominance of lactic acid producing bacteria for example *Lactobacillus*. The lactic acid preserves the nutritional value of silage by preventing putrefaction. Benefits of new technology in improving the silage making process.	Monitor changes in temperature and pH in a model silage silo.
ii Soil inoculants.	The use of mychorrhizal inoculants in the establishment of colonising plants in land reclamation. The use of *Rhizobium* inoculant when sowing legumes to increase yield.	Inoculate legumes with *Rhizobium*.
iii Techniques in breeding.		
Selective breeding.	Selective breeding as a means of improving crops and animals by maximizing desired characteristics and reducing undesirable features. Limitations of this method in terms of time taken and variable results of trial and error.	
Genome mapping.	Genome mapping as a means of identifying the function and location of genes on chromosomes leading to the identification of desirable genes.	

National Course Specification: course details (cont)

Unit 3: Biotechnology Processes (Intermediate 2)

CONTENT	NOTES	LEARNING ACTIVITIES
Genetic modification.	Genetic modification as the ability to introduce desirable genes from the same or different species into chromosomes.	
Animal examples.	Use of genome mapping to speed up selective breeding programmes. Potential of genetic modification to introduce desirable characteristics.	
Plants examples.	Transfer of genes that confer pest and disease resistance to crop plants from non crop plants and bacteria.	Carry out mustard tissue culture.
	Use of tissue culture techniques to make many plants from small sample or growing plants that are difficult to reproduce by other methods.	Discuss the economic, social and ethical issues relating to the use of GM crops.
b) Pharmaceuticals		
i Production of antibiotics in terms of the organism involved, its uses and benefits.	Antibiotics as chemical substances produced by micro-organisms which at low concentrations have a growth inhibiting effect on other micro-organisms. Production of penicillin in a *Penicillium* suspension. The importance of controlling pH, temperature, nutrient and oxygen levels to maximise production. The use of antibiotics in the treatment of human diseases. The clinical requirement for stability of antibiotics in acids and their low toxicity. Broad spectrum and narrow spectrum antibiotics.	Investigate the effects of antibiotic multi-disks on the growth of a bacterium.

National Course Specification: course details (cont)

Unit 3: Biotechnology Processes (Intermediate 2)

CONTENT	NOTES	LEARNING ACTIVITIES
ii Production of insulin in terms of organism involved, its uses and benefits.	Problems associated with traditional sources of insulin. Bacteria eg *E.coli* can be genetically engineered to produce human insulin by: human gene for insulin isolated; human insulin gene inserted into plasmid; plasmid containing human insulin gene put into bacterium; bacteria grow in culture and produce human insulin; human insulin separated and purified for treatment of diabetes.	
c) Food		
i Production of single cell protein (SCP) in terms of organism involved, use and benefits of product.	Single cell protein (SCP) is harvested and used for food which has a high protein content Micro-organisms are grown on waste or cheap materials. Materials have included whey from the cheese industry and molasses from sugar refining. For example meat substitute made by fungus (name not required).	Monitor the growth of *Klyvermyces lactis* on whey to illustrate growth of biomass from waste material.
ii Food preservation.		
The use of micro-organisms and their metabolites in the production of food preservatives as illustrated by the metabolites vinegar (acetic acid), citric acid, and lactic acid. Named micro-organism involved in each case and benefits of use of product.	Vinegar (acetic acid) production by the bacterium *Acetobacter* from ethanol products. Its preservative action and use in flavouring. Citric acid production by the fungus *Aspergillus niger* using a molasses substrate. Use as a flavour enhancer, antioxidant and acidity regulator. Lactic acid production by the bacteria *Lactobacilli* using glucose. Its use as a flavour enhancer, antioxidant and acidity regulator. The use of lactic acid bacteria in yoghurt and cheese manufacture.	Investigate the effects of different preservatives on the growth of micro-organisms in peas.

National Course Specification: course details (cont)

Unit 3: Biotechnology Processes (Intermediate 2)

CONTENT	NOTES	LEARNING ACTIVITIES
d) Energy		
i Production of energy sources in terms of the variety of organisms involved in the process, the use and benefits of the product.	The fixation of energy into biomass by photosynthesis. Biomass as a renewable energy source (fuel). Energy crops and organic wastes are used as sources of biomass for the production of fuels.	
ii Biomass as an energy source.		
iii Ethanol production.	Micro-organisms produce ethanol from sugars obtained from energy crops e.g. sugar cane. Some energy crops eg maize require pre-treatment with enzymes to produce sugars.	Investigate the effect of amylase on starch.
	Batch processing using *Saccharomyces* species and continuous processing using immobilised cells of Zygomonas. Advantages of using immoblised cells.	Demonstrate the use of immobilised yeast in fermentation
	Separation of ethanol by distillation for use directly or mixing with petrol to produce gasohol. The financial and environmental advantages of using gasohol as a fuel.	
iv Methane production	The presence of methane producing micro-organisms in organic waste eg animal dung. Methane production in anaerobic digesters and its use.	
	Methane production and collection of methane from urban waste landfill sites. Benefits of gas extraction for fuel.	Obtain and present information on methane production in landfill sites.

National Course Specification: course details (cont)

Unit 3: Biotechnology Processes (Intermediate 2)

CONTENT	NOTES	LEARNING ACTIVITIES
e) Biodegradation Sewage treatment in terms of the variety of micro-organisms involved and the benefits of the process.	Production of effluent (liquid) and sludge (solid) by sedimentation. Organic waste in the effluent is broken down by micro-organisms using aerobic respiration. This process is carried out by activated sludge treatment or biological filters. In activated sludge treatment, aerobic conditions are created by bubbling air into the tanks. In biological filters aerobic conditions are created by trickling the effluent through stones. Organic waste in sludge (solid) is broken down by micro-organisms using anaerobic respiration. A variety of aerobic and anaerobic micro-organisms are required for complete break down of organic waste. Problems associated with heavy metal and foaming detergent contamination.	Investigate the effect of aeration on fungal growth in liquid medium. Discuss case studies of use of reed bed filtration systems.

National Course Specification: course details (cont)

COURSE Biotechnology (Intermediate 2)

ASSESSMENT

To gain the award of the course, the candidate must pass all unit assessments as well as the external assessment. External assessment will provide the basis for grading attainment in the course award.

When units are taken as component parts of a course, candidates will have the opportunity to achieve at levels beyond that required to attain each of the unit outcomes. This attainment may, where appropriate, be recorded and used to contribute towards course estimates and to provide evidence for appeals. Further information on the key principles of assessment are provided in the paper *Assessment* (HSDU, 1996) and in *Managing Assessment* (HSDU, 1998).

DETAILS OF THE INSTRUMENTS FOR EXTERNAL ASSESSMENT

The external course examination will sample across all the learning outcomes, and achievement will be graded on the basis of cut-off scores.

The assessment of knowledge and understanding, problem solving and practical abilities will be based upon the course content and notes described for the three units:

- *The Biology of Micro-organisms (Intermediate 2)*
- *Working with Micro-organisms (Intermediate 2)*
- *Biotechnology Processes (Intermediate 2)*

The content contexts of these units will be sampled using a weighting of 2:1:2 in the course examination which will include familiar contexts as well as contexts which are less familiar and more complex than in the unit assessments. While there are no compulsory practicals for the purposes of external assessment, there will be questions set in the examination on practical work in contexts less familiar to the candidates.

The course examination will consist of one paper of 2 hours with a total of 100 marks. The paper will consist of three sections:

Section A

This section will contain 25 multiple-choice questions. Of these, between 9 and 11 will test problem solving and/or practical abilities, the remainder will test knowledge and understanding. Section A will have an allocation of 25 marks. Candidates will be expected to answer all the questions.

Section B

This section will contain structured questions with an allocation of 65 marks. Between 15 and 20 marks will test problem solving and/or practical abilities, the remainder will test knowledge and understanding. Candidates will be expected to answer all the questions.

Section C

This section will consist of four extended response questions to test the candidates' ability to select, organise and present relevant knowledge. Candidates will be expected to answer two of the four questions. Section C will have an allocation of 10 marks (5 to each extended response question).

National Course Specification: course details (cont)

COURSE Biotechnology (Intermediate 2)

GRADE DESCRIPTIONS

Grade C

Candidates at Grade C will have demonstrated success in achieving the component units of the course. In the course assessment candidates will generally have demonstrated the ability to:

- retain knowledge and skills over a longer period of time
- integrate knowledge and understanding, problem solving and practical abilities acquired across component units
- apply knowledge and understanding, problem solving and practical abilities in similar contexts to those in the unit outcomes.

Grade A

In addition, candidates at Grade A will generally have demonstrated the ability to:

- retain an extensive range of knowledge and skills over an extended period of time
- integrate an extensive range of knowledge and understanding, problem solving and practical abilities acquired across component units
- apply knowledge and understanding, problem solving and practical abilities in contexts less familiar and more complex than in the unit outcomes.

Testing of the course outcomes

The following gives advice on how the course outcomes will be assessed.

Knowledge and understanding

Candidates should be tested on their ability to recall learning and understand facts and principles detailed in the content statements and supplementary notes in the content tables in the course specification.

Problem solving and practical abilities

Questions relating to each of the following points will be included in the course examination in order to test the candidate's ability to:

1. Select relevant information from texts, tables, charts, keys, graphs and/or diagrams.
2. Present information appropriately in a variety of forms, including written summaries, extended writing, tables and/or graphs.
3. Process information accurately using calculations where appropriate. Calculations to include percentages, averages and/or ratios. Significant figures and units should be used appropriately.
4. Plan and design experimental procedures to test given hypotheses or to illustrate particular effects. This could include identifications, controls and measurements or observations required.
5. Evaluate experimental procedures in situations that are unfamiliar, by commenting on the purpose of approach, the suitability and effectiveness of procedures, the control of variables, the limitations of equipment, possible sources of error and/or suggestions for improvement.

6. Draw valid conclusions and give explanations supported by evidence or justification. Conclusions should include reference to the overall pattern to readings or observations, trends in results or comment on the connection between variables and controls.
7. Make predictions and generalisations based on available evidence.

Complexity of Data
The following advice is intended as general guidelines in setting the complexity of data to be used in problem solving questions.

At Intermediate 2 typically one source of data (text, tables, charts, keys, diagrams or graphs) should be provided from which the problem has to be solved.

The provided data should typically have one to two patterns, trends, conditions, variables or sets of results from which information has to be selected and presented or which have to be used as sources of evidence for conclusions, explanations, predictions or generalisations. The analysis of data should involve one set of data.

The planning, designing and evaluation of experimental procedures should involve one of the following: one or two treatments, adequate controls, limitations of equipment, sources of error, and possible improvements as appropriate.

DETAILS OF THE INSTRUMENTS FOR INTERNAL ASSESSMENT

Unit: The Biology of Micro-organisms (Intermediate 2)

Outcomes 1 and 2

Outcomes 1 and 2 are assessed by a single holistic closed-book test with questions covering all the performance criteria for knowledge and understanding and problem solving. The ratio of the marks allocated to Outcomes 1 and 2 is 3:2.

Outcome 3

A report of one problem solving activity related to Intermediate 2 Biotechnology is required covering all the performance criteria set out in the unit specification.

Candidates are only required to produce one report on a problem solving activity for Intermediate 2 Biotechnology. This report can be used as evidence for Outcome 3 in the 'The Biology of Micro-organisms' and for Outcome 2 in 'Biotechnology Processes'.

Unit: The Biology of Micro-organisms (Intermediate 2)

Outcome 1

Outcome 1 is assessed by closed-book test covering all of the performance criteria for this outcome.

Outcome 2

Outcome 2 is assessed by a checklist of microbiological techniques.

Unit: Biotechnology Processes (Intermediate 2)

Outcome 1

Outcome 1 is assessed by a closed-book test which tests the performance criteria for this outcome.

Outcome 2

A report of one problem solving activity related to Intermediate 2 Biotechnology is required, covering all the performance criteria set out in the unit specification.

Candidates are only required to produce one report on a problem solving activity for Intermediate 2 Biotechnology. This report can be used as evidence for Outcome 3 in the 'The Biology of Micro-organisms' and for Outcome 2 in 'Biotechnology Processes'.

APPROACHES TO LEARNING AND TEACHING

Suggestions for appropriate learning activities are contained within the tables of course content. An investigative approach should be taken to the learning and teaching of Biotechnology. Such an approach not only draws heavily on experimental work, but should provide opportunities to develop individual and group research using a variety of resources alongside the more traditional approaches of whole class teaching.

Practical work should contain a balance of illustrative experimental work and investigative practical work. Practical work can provide one way of delivering theoretical knowledge related to knowledge and understanding performance criteria. Practical investigations should be used to develop both problem solving and practical skills and not just to provide reports for the purposes of internal assessment. For example, investigative work provides opportunities to develop the problem solving performance criteria of planning and designing an investigation and presents opportunities to make predictions and generalisations which can then be tested in practical contexts.

Laboratory work should include the use of instrumentation and equipment that reflects current scientific use. Opportunities should be taken to capture data through computer interfacing, data loggers or videos. Such data may then be analysed by information technology (IT) or used for control technology.

Use of the additional 40 hours

This time should be distributed throughout the duration of the course. It should be used:

- to provide an introduction to the course and assessment methods
- to allow more practical work to be undertaken by the candidates
- for remediation of particular aspects of work in which candidates require to be re-assessed
- for consolidation and integration of learning
- to practice techniques in answering multiple-choice questions
- to develop extended response writing skills
- to practise applying knowledge and understanding, problem solving and practical abilities in contexts more complex than in the units
- to complete Outcome 3 reports.

National Course Specification: course details (cont)

COURSE Biotechnology (Intermediate 2)

SPECIAL NEEDS

This course 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).

National Unit Specification: general information

UNIT The Biology of Micro-organisms (Intermediate 2)

NUMBER DF5F 11

COURSE Biotechnology (Intermediate 2)

SUMMARY

This unit seeks to develop knowledge and understanding, problem solving and practical abilities in the context of the structure and reproduction, biochemistry and ecology of micro-organisms. This is a component unit of Intermediate 2 Biotechnology.

OUTCOMES

1 Demonstrate knowledge and understanding related to the Biology of Micro-organisms.
2 Solve problems related to the Biology of Micro-organisms.
3 Solve problems related to Intermediate 2 Biotechnology.

RECOMMENDED ENTRY

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

- Standard Grade Biology
- Intermediate 1 Biology.

Previous biology experience is not an absolute requirement and the course is therefore also suitable for those wishing to study biotechnology with a background in other sciences.

Administrative Information

Superclass: RH

Publication date: March 2004

Source: Scottish Qualifications Authority

Version: 01

National Unit Specification: general information (cont)

UNIT The Biology of Micro-organisms (Intermediate 2)

CREDIT VALUE

1 credit at Intermediate 2 (6 SCQF credit points at SCQF 5*)

**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

This unit gives automatic certification of the following:

Complete core skills for the unit	Problem Solving	Int 2
Additional core skills for the unit	Using Graphical Information	Int 2

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 The Biology of Micro-organisms (Intermediate 2)

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 the Biology of Micro-organisms.

Performance criteria

(a) The biology of micro-organisms is described correctly in relation to their structure and reproduction.
(b) The biology of micro-organisms is described correctly in relation to their biochemistry.
(c) The biology of micro-organisms is described correctly in relation to their ecology.

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 the Biology of Micro-organisms.

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 in the context of the structure and reproduction, biochemistry or the ecology of micro-organisms.

National Unit Specification: statement of standards (cont)

UNIT The Biology of Micro-organisms (Intermediate 2)

OUTCOME 3

Solve problems related to Intermediate 2 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 Intermediate 2 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 The Biology of Micro-organisms (Intermediate 2)

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 and reproduction of micro-organisms

i Bacteria.
Cellular structure and function.
Shape.
Reproduction.

ii Viruses.
Structure.
Replication.

iii Fungi.
Cellular structure of fungi as exemplified by yeast and *Mucor.*
Reproduction in yeast and *Mucor.*

iv Algae.
Cellular structure and function in unicellular algae as exemplified by *Chlorella*
Reproduction.

v Protozoa.
Cellular structure and function in protozoa.
Reproduction.

b) Biochemistry in micro-organisms

i Photosynthesis.
ii Mineral nutrition.
iii Enzymes.
iv Respiration.
v Biochemical synthesis.

c) Ecology of micro-organisms

i Nutrition.
Saprophytic nutrition.
Parasitic nutrition.
Mycorrhizal associations.
Root nodules.

ii Nutrient cycling.
The carbon cycle.
The nitrogen cycle.

National Unit Specification: support notes (cont)

UNIT The Biology of Micro-organisms (Intermediate 2)

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

Outcomes 2 and 3

Suitable learning activities for the development of problem solving skills for Outcome 2 and for the purposes of Outcome 3 include:

- investigate the growth and/or productivity of a *Chlorella* culture under different light conditions
- investigate the limiting factors of photosynthesis using a *Chlorella* culture
- investigate the effects of mineral deficiency in a *Chlorella* culture
- investigate the effects of nutrient enrichment on the growth of yeast cultures
- carry out an assay of extracellular enzyme activity, eg Amylase activity of *B. subtilis*
- test for end products of yeast and *Lactobacilli* fermentations
- carry out an assay for antibiotics produced by *Penicillium*
- observe succession of fruiting bodies on decaying organic matter
- measure temperature changes in compost heap due to thermophilous fungi
- measure the rate of decay of malt extract by the loss of weight in a yeast culture
- carry out an assay of cellulase activity in soil using cellulose strips.

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.

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 Intermediate 2 Biotechnology.

Candidates are only required to produce one report on a problem solving activity for Intermediate 2 Biotechnology. This report can be used as evidence for Outcome 3 in the 'The Biology of Micro-organisms' and for Outcome 2 in 'Biotechnology Processes'.

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 The Biology of Micro-organisms (Intermediate 2)

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: • sources of information • set procedures • people • equipment/physical resources • materials
(c) Procedures appropriate to solving the problem are planned and designed.	The plan might include: • what is to be measured/collected • variable altered • variable kept constant • how many readings/measurements/observations/subjects • equipment/resources required • how data will be recorded, analysed and presented
(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: • for tabular presentation this must include: suitable headings and units showing averages or other appropriate computations • for graphical presentation this must include: data presented as a histogram, bar chart, connected points, line of best fit as appropriate, with suitable scales and axes labelled with quantities and units and with data correctly plotted.
(c) The problem solving procedure is evaluated.	The evaluation might include: • an assessment of the effectiveness of the procedure including: planning and organising and the outcome of the activity • drawing valid conclusions, which make use of the presented evidence • suggestions for alternative or modified strategies, further work, predictions or generalisations • an assessment/explanation of the relevance of the results

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 for the specific performance criterion identified in need of further attention ie the entire report does not need to be rewritten.

Conditions required to complete the report

Candidates may complete their reports outwith class time provided reasonable measures are taken to ensure that the report is the individual work of the candidate.

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 candidate's 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, 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).

National Unit Specification: general information

UNIT Working with Micro-organisms (Intermediate 2)

NUMBER D039 11

COURSE Biotechnology (Intermediate 2)

SUMMARY

This unit seeks to develop knowledge, understanding and practical skills in the microbiological techniques of plate pouring, subculturing micro-organisms, sampling the environment, separating a mixed culture, staining and microscopy. This is a component unit of Intermediate 2 Biotechnology.

OUTCOMES

1 Demonstrate knowledge and understanding related to microbiological techniques.
2 Carry out techniques related to microbiology.

RECOMMENDED ENTRY

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

- Standard Grade Biology
- Intermediate 1 Biology.

Previous biology experience is not an absolute requirement and the course is therefore also suitable for those wishing to study biotechnology with a background in other sciences.

Administrative Information

Superclass: RH

Publication date: June 2002

Source: Scottish Qualifications Authority

Version: 04

National Unit Specification: general information (cont)

UNIT Working with Micro-organisms (Intermediate 2)

CREDIT VALUE

1 credit at Intermediate 2 (6 SCQF credit points at SCQF 5*)

**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

There is no automatic certification of core skills or core skills components in this unit.

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 Working with Micro-organisms (Intermediate 2)

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 microbiological techniques.

Performance criteria

(a) Work with micro-organisms is described correctly in relation to microbiological procedures.
(b) The microscopic examination of micro-organisms is described correctly in terms of microscopy and simple staining techniques.

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

Carry out techniques related to microbiology.

Performance criteria

(a) The preparation for work is in accordance with given specifications.
(b) Techniques are carried out in accordance with safe practice and given specifications.
(c) The record of work is clear and accurate.
(d) Results and relevant observations are reported clearly.

Note on the range for the outcome

Techniques: plate pouring; subculturing micro-organisms; separating a mixed culture; staining and microscopy.

Evidence requirements

A checklist of the individual work of the candidate covering all of the above performance criteria for all of the range.

National Unit Specification: support notes

UNIT Working with Micro-organisms (Intermediate 2)

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) Microbiological procedures

i Preparation of person.
Preparation of work space.

ii Aseptic transfer operations and reasons for each stage in the procedure.

iii Pouring plates.

iv Subculturing micro-organisms.
Loop transfer.
Streak plate inoculation.
Transfer of fungal mycelium.

v Separating micro-organisms.

b) Microscopy

i Microscopic examination of micro-organisms.
Parts and functions of the light microscope.
Calculation of total magnification.

ii Simple staining techniques.
The processes of fixing and staining leading to the examination of dead micro-organisms.
Use of vital stains.

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

Outcome 2

Suitable learning activities for this outcome include:

- prepare work space: use Benchkote or similar if necessary, swab surface with a suitable disinfectant, set out materials and equipment in an organised fashion
- bring agar to pouring temperature, pour plates, label and store
- examine poured plates for contamination
- loop transfer of micro-organisms: solid to solid; solid to liquid; liquid to solid; liquid to liquid
- streak plate inoculation
- transfer block of agar containing fungal mycelium from plate to plate using a sterile scalpel
- use a swab to sample the environment and plate out

- streak out a mixed bacterial broth culture of two bacteria to produce individual colonies
- examine fresh material under bright and dark field illumination (and phase contrast if available)
- examine prepared specimens (including oil immersion if available)
- examine photomicrographs of micro-organisms taken with electron microscopy and phase contrast
- calculate magnification and specimen size
- use simple stains to examine a range of micro-organisms to show the variety of shapes and structures
- stain cultures of fungi and bacteria with, eg methylene blue and carbol fuchsin
- stain smears of yoghurt with nigrosin to visualise bacteria
- stain smears of root nodules with carbol fuchsin for *Rhizobium*.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

Details of suitable approaches are detailed in the course specification.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Outcome 1

Outcome 1 for this unit is assessed by a test designed to provide evidence that the outcome and performance criteria have been achieved.

Outcome 2

Candidates are required to demonstrate competence in carrying out the following techniques: pouring plates; subculturing micro-organisms; separating a mixed culture; staining and microscopy.

The National Assessment Bank provides guidance on assessment of performance of these techniques in relation to the performance criteria.

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).

National Unit Specification: general information

UNIT Biotechnology Processes (Intermediate 2)

NUMBER DF5G 11

COURSE Biotechnology (Intermediate 2)

SUMMARY

This unit seeks to develop knowledge and understanding, problem solving and practical abilities in the context of biotechnological applications and processes.

OUTCOMES

1 Demonstrate knowledge and understanding related to applications of biotechnology.
2 Solve problems related to Intermediate 2 Biotechnology.

RECOMMENDED ENTRY

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

- Standard Grade Biology
- Intermediate 1 Biology.

Previous biology experience is not an absolute requirement and the course is therefore also suitable for those wishing to study biotechnology with a background in other sciences.

Administrative Information

Superclass: RH

Publication date: March 2004

Source: Scottish Qualifications Authority

Version: 01

National Unit Specification: general information (cont)

UNIT Biotechnology Processes (Intermediate 2)

CREDIT VALUE

1 credit at Intermediate 2 (6 SCQF credit points at SCQF 5*)

**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 Biotechnology Processes (Intermediate 2)

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 applications of biotechnology.

Performance criteria

(a) Biotechnology processes are described correctly in terms of the organism involved, the raw materials/substrate and conditions required.
(b) Applications of biotechnology processes are described correctly in terms of the product, use of the product and benefits in relation to agriculture and pharmaceuticals; food, energy and biodegradation.

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 Intermediate 2 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 Intermediate 2 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 (cont)

UNIT Biotechnology Processes (Intermediate 2)

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) Agriculture

i Silage.
ii Soil inoculants.
iii Techniques in breeding.
Selective breeding.
Genome mapping.
Genetic modification.
Animal examples.
Plants examples.

b) Pharmaceuticals

i Production of antibiotics in terms of the organism involved, its uses and benefits.
ii Production of insulin in terms of organism involved, its uses and benefits.

c) Food

i Production of single cell protein (SCP) in terms of organism involved, use and benefits of product.
ii Food preservation.
The use of micro-organisms and their metabolites in the production of food preservatives as illustrated by the metabolites vinegar (acetic acid), citric acid, and lactic acid. Named micro-organism involved in each case and benefits of use of product.

d) Energy

i Production of energy sources in terms of the variety of micro-organisms involved in the process, the use and benefits of the product.
ii Biomass as an energy source.
iii Ethanol production.
iv Methane production.

e) Biodegradation

Sewage treatment in terms of the variety of micro-organisms involved and the benefits of the process.

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

National Unit Specification: support notes (cont)

UNIT Biotechnology Processes (Intermediate 2)

Outcome 2

Examples of suitable learning activities for this outcome include:

- monitor changes in temperature and pH in a model silage silo
- carry out mustard tissue culture
- monitor the growth of *Klyvermyces lactis* on whey to illustrate growth of biomass from waste material
- investigate the effects of different preservatives on the growth of micro-organisms in peas
- compare the effects of freezing milk products in the absence and presence of the enzyme lactase
- demonstrate the use of immobilised yeast in fermentation
- obtain and present information on methane production in landfill sites
- investigate the effect of aeration on fungal growth in liquid medium.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

Details of suitable approaches are detailed in the course specification.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

The National Assessment Bank provides advice on suitable approaches.

Outcome 1

Outcome 1 for this unit should be assessed by a holistic test designed to provide evidence that the outcome and performance criteria have been achieved.

Outcome 2

This involves the submission of one report of a problem solving activity related to Intermediate 2 Biotechnology.

Candidates are required to produce only 1 report on a problem solving activity for Intermediate 2 Biotechnology. This report can be used as evidence for Outcome 3 in the 'The Biology of Micro-organisms' and for Outcome 2 in 'Biotechnology Processes'.

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 Biotechnology Processes (Intermediate 2)

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: • sources of information • set procedures • people • equipment/physical resources • materials.
(c) Procedures appropriate to solving the problem are planned and designed.	The plan might include: • what is to be measured/collected • variable altered • variable kept constant • how many readings/measurements/observations/subjects • equipment/resources required • how data will be recorded, analysed and presented.
(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: • for tabular presentation this must include: suitable headings and units showing averages or other appropriate computations • for graphical presentation this must include: data presented as a histogram, bar chart, connected points, line of best fit as appropriate, with suitable scales and axes labelled with quantities and units and with data correctly plotted.
(e) The problem solving procedure is evaluated.	The evaluation might include: • an assessment of the effectiveness of the procedure including: planning and organising and the outcome of the activity • drawing valid conclusions, which make use of the presented evidence • suggestions for alternative or modified strategies, further work, predictions or generalisations • an assessment/explanation of the relevance of the results.

National Unit Specification: support notes (cont)

UNIT Biotechnology Processes (Intermediate 2)

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).