



## Higher National Unit specification

### General information for centres

**Unit title:** Biotechnology: An Introduction

**Unit code:** DJ00 34

**Unit purpose:** This Unit is designed to introduce candidates to biotechnology while reinforcing key aspects of cell function at a molecular level.

On completion of the Unit the candidate should be able to:

1. Describe the fundamental processes common to all cells.
2. Describe and explain the process of genetic engineering.
3. Describe the production of useful proteins, cells and metabolites.
4. Describe and demonstrate biotechnological processes in industry.
5. Discuss bioethics and consumer concerns regarding biotechnology processes.

**Credit points and level:** 1 HN credit at SCQF level 7: (8 SCQF credit points at SCQF level 7\*)

*\*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.*

**Recommended prior knowledge and skills:** Access to this Unit will be at the discretion of the centre but it is recommended that candidates should have experience of studying Biology at Standard Grade Credit or Intermediate 2 level.

**Core Skills:** There may be opportunities to gather evidence towards the Core Skill Working with Others at higher level in this Unit although there is no automatic certification of Core Skills or Core Skill components.

**Context for delivery:** This Unit is included in the framework of the Group Award, HND Biotechnology. It is recommended that it should be taught and assessed within the context of the particular Group Award to which it contributes.

**Assessment:** Candidates must meet the level of performance specified in the Evidence Requirements for all five Outcomes to achieve the Unit. Outcomes 1 – 3 will be assessed by a holistic closed-book assessment under supervised conditions with a cut off score of 60%. Outcome 4 will be assessed by a written report and Outcome 5 will be assessed by an oral presentation or debate.

## Higher National Unit specification: statement of standards

**Unit title:** Biotechnology: An Introduction

**Unit code:** DJ00 34

The sections of the Unit stating the Outcomes, knowledge and/or skills, and Evidence Requirements are mandatory.

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. Candidates 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

Describe the fundamental processes common to all cells

#### Knowledge and/or Skills

- ◆ Flow of genetic information
- ◆ Specific binding in protein
- ◆ Basic organisation of biochemical pathways
- ◆ The role of the cell membrane

#### Evidence Requirements

Candidates will need evidence to demonstrate their knowledge and understanding of the fundamental processes common to all cells. On each occasion, two from each of the bullet points listed in the knowledge and skills for Outcome 1 must be assessed.

Candidates will need evidence to demonstrate their knowledge and/or skills by showing they can:

- ◆ describe the flow of genetic information (in summary) according to the following:
  - modular construction of protein and nucleic acid chains
  - information storage in the base sequence of genes
  - information flow from DNA to mRNA to protein
  - 1 gene – 1 protein
  - transcription
  - translation
- ◆ describe specific binding in protein function according to the following:
  - precise 3D structures and precisely shaped binding sites
  - lock and key analogy
  - numerous weak non-covalent bonds

## Higher National Unit specification: statement of standards (cont)

### Unit title: Biotechnology: An Introduction

- ◆ describe briefly the basic organisation of biochemical pathways according to the following:
  - one step, one enzyme
  - enzymes as specific catalysts
  - role of ATP in outline
- ◆ describe the role of the cell membrane according to the following:
  - specific transport proteins
  - receptors

### Outcome 2

Describe and explain the process of genetic engineering

#### Knowledge and/or Skills

- ◆ Cutting of long DNA molecules
- ◆ Cloning of a DNA fragment
- ◆ Propagation of recombinant plasmids
- ◆ Methods of overexpressing a protein

#### Evidence Requirements

Candidates will need evidence to demonstrate their knowledge and understanding of the process of genetic engineering by showing that they can:

- ◆ explain the cutting of long DNA molecules by restriction enzymes into smaller fragments which have sticky ends
- ◆ explain the cloning of a DNA fragment which involves linking it to a suitable vector such as a plasmid, by ligation to produce a recombinant (plasmid) molecule.
- ◆ explain how a recombinant plasmid is propagated following transformation/transfection of a suitable host cell.
- ◆ describe methods for overexpressing a protein once its coding sequence has been cloned, specifically alteration of sequences upstream of the coding sequence to enhance gene expression.

## **Higher National Unit specification: statement of standards (cont)**

**Unit title:** Biotechnology: An Introduction

### **Outcome 3**

Describe the production of useful proteins, cells and metabolites

#### **Knowledge and/or Skills**

- ◆ Upstream processing
- ◆ Downstream processing

#### **Evidence Requirements**

Candidates will need evidence to demonstrate their knowledge and understanding of the production of useful proteins, cells and metabolites. On each occasion, three from the upstream processing list and two from the downstream processing list must be assessed. A different sample should be chosen on each assessment occasion to prevent candidates being able to foresee what they will be asked.

Candidates will need evidence to demonstrate their knowledge and/or skills by showing they can:

- ◆ describe upstream processing according to the following:
  - fermentation
  - sterile procedures
  - control systems
  - possible substrates used
  - possible microorganisms used
- ◆ describe downstream processing according to the following:
  - cell harvesting (centrifugation, filtration)
  - drying
  - cell disruption
  - waste disposal

#### **Assessment Guidelines**

Assessment of Outcomes 1 - 3 is by a closed-book holistic assessment under supervised conditions. The assessment should have a cut off score of 60%.

## **Higher National Unit specification: statement of standards (cont)**

**Unit title:** Biotechnology: An Introduction

### **Outcome 4**

Describe and demonstrate biotechnological processes in industry

#### **Knowledge and/or Skills**

- ◆ Industrial applications of biotechnology
- ◆ Organism used in the process
- ◆ Equipment
- ◆ End use

#### **Evidence Requirements**

Candidates will need to demonstrate their knowledge and/or skills by showing that they can:

- ◆ produce a written report for one biotechnological process in industry

The reports produced should incorporate different aspects of the process depending on the application investigated. The following points should be incorporated where appropriate:

- ◆ a description of the process eg. Word description, annotated diagrams, flow charts, use of chemical/ biochemical equations
- ◆ equipment used
- ◆ identification of organism or product from organism utilised in the process
- ◆ use of end product
- ◆ bibliography

#### **Assessment Guidelines**

This Outcome should be assessed by the production of one report of a biotechnological process such as fermentation, silage and enzyme production. The report should be approximately 1500 words. Some suggestions on the topics for the report are given in the support notes.

### **Outcome 5**

Discuss bioethics and consumer concerns regarding biotechnology processes

#### **Knowledge and/or Skills**

- ◆ Bioethics.
- ◆ Consumer concerns.
- ◆ Consumer acceptance.

## **Higher National Unit specification: statement of standards (cont)**

**Unit title:** Biotechnology: An Introduction

### **Evidence Requirements**

Candidates will need evidence to demonstrate their knowledge and understanding of bioethics and consumer concerns regarding biotechnology by showing they can do one of the following:

- ◆ deliver an oral presentation for a minimum of five minutes, followed by questions, incorporating at least two of the bullet points in the knowledge and/or skills listed above.
- ◆ take part in a group debate where candidates discuss all knowledge and/or skills

A detailed observation checklist and/or a video recording, and support materials should be retained as evidence of performance for each candidate.

### **Assessment Guidelines**

This Outcome will be assessed by means of a checklist and/or video recording to record performance for the oral presentation or the debate. The presentation should be delivered to a peer group and following which candidates must respond to audience questions.

## Administrative Information

**Unit code:** DJ00 34

**Unit title:** Biotechnology: An Introduction

**Superclass category:** RH

**Original date of publication:** August 2004

**Version:** 02 (June 2009)

### History of changes:

Version	Description of change	Date
02	Changes made to standardise assessment guidelines.	03/06/09

**Source:** SQA

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## Higher National Unit specification: support notes

### Unit title: Biotechnology: An Introduction

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 the content and context for this Unit

#### Outcome 1

The approach here is **very brief** and **basic**, to provide a foundation for the later Outcomes. Flow of genetic information: introduction to living things, cells tissues. Basic structure and function of proteins, DNA, RNA. Transcription and translation.

Specific binding and protein function: protein specificity, binding site, bonding- weak covalent, hydrogen bonds. Egs. Of specificity enzymes/substrates, antibody/antigen, hormones/receptors.

Basic organisation of biochemical pathways: metabolism, catalysts, small steps, 'one step one enzyme' - A->B->C->D. Role of ATP.

Role of the cell membrane: specific transport proteins, specific binding receptor, proteins.

#### Outcome 2

This Outcome should cover the simplest methods for the transfer of genes between organisms.

- ◆ Cutting of long DNA molecules

- ◆ Restriction enzymes

Random distribution of sites for a particular restriction enzyme.

Staggered cleavage to give sticky ends which can base-pair to any identical sticky ends.

- ◆ Cloning of a DNA fragment

Need for a cloning vector – only plasmids should be covered. Cut plasmid with same restriction enzyme as the DNA to be cloned. Ligation, using DNA–ligase and ATP, to give a recombinant plasmid

- ◆ Propagation of recombinant plasmids

Only e-coli should be considered as a host cell.

Transformation/transfection (in outline)



## Higher National Unit specification: support notes (cont)

### Unit title: Biotechnology: An Introduction

Individual colonies on a plate contain different fragments of DNA (if a mixture of fragments was ligated) ie each colony is a clone. [Methods for screening for a clone of interest should not be covered]

- ◆ Methods of overexpressing a protein

“Cut and paste” approach to constructing a recombination plasmid, having the protein coding sequence downstream of an efficient ribosome binding site which is downstream of an efficient promoter (efficiency being with respect to the host cell).

### Outcome 3

- ◆ Bearing in mind that this Unit is introductory, this topic should be covered briefly, to give an awareness of the basics of fermentation without too much detail.
- ◆ Upstream processing
- ◆ Fermentation: batch, continuous
- ◆ Sterile procedures: disinfection, steam treatment
- ◆ Control systems: negative feedback mechanism, bioreactor system- control eg. pH, oxygen, foam, temperature.
- ◆ Possible substrates: corn syrup, molasses, whey etc.
- ◆ Possible micro organisms: bacteria, fungi.
- ◆ Downstream processing
- ◆ Cell harvesting: separation, concentration, purification packaging.
- ◆ Drying: spray, fluidised bed, freeze.

### Outcome 4

The following applications are examples which may be selected.

- ◆ Traditional applications
  - existing natural processes which are used in food and drink manufacture: yoghurt, bread, cheese, sauerkraut, soy sauce, beer, wine etc
  - existing natural processes which are used in waste treatment or disposal:
    - sewage treatment, breakdown of oil (or other hydrocarbons), spills, PCB's, phenol, heavy metal absorption.
- ◆ Secondary metabolite production
  - many antibiotics: penicillin, streptomycin etc
- ◆ Artificial selection of improved strains
  - regulatory mutants which overproduce a desired amino acid
  - artificial selection of *Pseudomonas* strains with the ability to metabolise new amides.

## Higher National Unit specification: support notes (cont)

### Unit title: Biotechnology: An Introduction

- ◆ Increased expression of the enzymes for a microbial biochemical pathway
  - increased expression of the whole route to phenylalanine (via chorismate) for use in making sweetener aspartame (NutraSweet).
- ◆ Biopharming - altered/engineered processes based on production of a mammalian protein in a microbial host cell
  - human insulin from E.coli/yeast, calf chymosin from yeast etc.
- ◆ Bioinformatics – using computer tools to analyse/sequence genetic information.
- ◆ Bioremediation - using microorganisms that occur naturally in soil to break down organic pollutants to less harmful compounds
  - land farming to bioremediate contaminated land
- ◆ Biosensors
  - eg use of enzymes to recognise the surface of a particular molecule and latch onto it, so targeting highly specific substances
  - eg use of light emitting organisms that lose their glow when they come into contact with a toxic substance, often used to determine general pollution.
- ◆ Transgenic organisms
  - medical: human diabetes insulin, recombinant (factor VIII) – haemophilia A
  - agriculture: Flavr Savr<sup>™</sup> tomato (altered ripening), cotton (herbicide resistance)
  - food: bovine chymosin from GM yeast (cheese production)
- ◆ Monoclonal antibodies
- ◆ Any other application deemed suitable by the centre.
- ◆ Candidates could be given guidelines on format of assessment and acceptable content (quality and quantity).

### Outcome 5

Candidates may contribute their own opinion in a general discussion of bioethical issues or they may be given a topic by the lecturer and divided into two groups for a debate. Candidates should source information from books, newspapers, interviews or the Internet for this Outcome.

If the candidates are working together as a group they should take into account the goals and tasks involved which make up the activity and should negotiate each person's roles and responsibilities.

## **Higher National Unit specification: support notes (cont)**

**Unit title:** Biotechnology: An Introduction

### **Guidance on the delivery and assessment of this Unit**

This Unit forms part of the Group Award, HND Biotechnology which is primarily designed to provide candidates with knowledge and skills related to employment/further study in biotechnology and science. The Unit should be delivered in a way that enables candidates to appreciate its relevance to the occupational area. Wherever possible, links should be drawn from situations which candidates will understand.

Assessment of Outcomes 1 - 3 is by supervised closed-book assessment. Where evidence is found to be unsatisfactory candidates may be given a reassessment paper under the same conditions. Different questions should be used in each reassessment and all points in the Evidence Requirements must be covered.

Assessment of Outcome 4 is by production of an appropriate written report of one practical investigation. This may differ from centre to centre depending upon the requirements of the candidate and the resources available in the delivering centre. All Evidence Requirements must be met by the candidate irrespective of mode of assessment. Where evidence is found to be unsatisfactory, and if appropriate, candidates may be questioned in order to identify particular problems in specific area(s). Support tutorials may prove useful in providing a solution to these problems. If the assessment is a written report, the most suitable remediation action is to allow the candidates to amend the written work and re-submit.

Assessment of Outcome 5 is by means of a 5 minute presentation or participation in a debate. If the presentation is unsatisfactory on the first attempt the candidate should be given a further attempt after remediation.

This Outcome should be integrated with the presentation skills Unit.

### **Open learning**

If this Unit is delivered by open or distance learning methods, additional planning resources may be required for candidate support, assessment and quantity assurance. A combination of new and traditional authentication tools may have to be devised for assessment and reassessment purposes.

### **Disabled candidates and/or those with additional support needs**

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website [www.sqa.org.uk/assessmentarrangements](http://www.sqa.org.uk/assessmentarrangements)

## **General information for candidates**

### **Unit title:** Biotechnology: An Introduction

This is a 1 credit HN Unit at SCQF level 7 intended for candidates undertaking an HNC/D Biotechnology. It is designed to provide you with a basic introduction to biotechnology while reinforcing key aspects of cell function at a molecular level. This Unit will also provide you with an opportunity to carry out biotechnological practicals in certain Outcomes.

On completion of this Unit you should be able to:

1. Describe the fundamental processes common to all cells.
2. Describe and explain the process of genetic engineering
3. Describe the production of useful proteins, cells and metabolites.
4. Describe and demonstrate biotechnological processes in industry.
5. Discuss bioethics and consumer concerns regarding biotechnology

The five Outcomes which make up the Unit are described below. Emphasis is placed on how these Outcomes are assessed.

#### **Outcome 1**

You will look at the flow of genetic information, specific binding in protein function, basic organisation of biochemical pathways and the role of the cell membrane at an introductory level.

The assessment for this Outcome is integrated with Outcomes 2 and 3 and is assessed by means of a supervised, closed-book test of which the passmark is 60%

#### **Outcome 2**

This Outcome describes techniques used in genetic engineering eg cutting of long DNA molecules, cloning of DNA fragments, propagation of recombinant plasmids and methods of overexpressing a protein.

The assessment for this Outcome is integrated with Outcomes 1 and 3 and is assessed by means of a supervised closed-book test of which the passmark is 60%

#### **Outcome 3**

In this Outcome you will learn about fermentation and associated procedures and processes eg upstream and downstream processing.

The assessment for this Outcome is integrated with Outcomes 1 and 2 and is assessed by means of a supervised closed-book test of which the passmark is 60%

## **General information for candidates (cont)**

**Unit title:** Biotechnology: An Introduction

### **Outcome 4**

In this Outcome you will investigate different biotechnological applications. The applications to be studied will be assessed by a written laboratory report.

### **Outcome 5**

In this Outcome you will be expected to deliver a 5 minute presentation on 2 of the knowledge and skills listed or participate in a group debate on all three of the knowledge and skills items listed in the Unit

This Outcome is assessed by observation of your presentation by the lecturer and peer group and the completion of a checklist and/or videotape.