Higher National Unit specification

General information for centres

Unit title: DNA Molecular Techniques: Theory and Practice

Unit code: DJ6X 35

Unit purpose: This Unit is designed to provide candidates with a practical introduction to, and an understanding of, some of the fundamental principles of molecular DNA technology. It is intended for candidates who are in the later stages of an HN science programme.

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

1. Describe the general principles of cloning DNA.
2. Describe techniques involving RNA and cDNA.
3. Describe the basic principles of PCR.
4. Describe the applications of molecular DNA technology and the implications to the biotechnology industry.
5. Demonstrate practical skills in molecular biological techniques.

Credit points and level: 2 HN credits at SCQF level 8: (16 SCQF credit points at SCQF level 8*)

**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. There are no specific entry requirements, however, it is recommended that candidates should have achieved relevant units at SCQF Level 7, including the DNA Structure and Function Unit.

Core Skills: There may be opportunities to gather evidence towards Core Skills in communication and problem solving at a higher level in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Context for delivery: This Unit is intended to be part of the HNC/D Science Group Awards. It is recommended that it should be taught and assessed within the subject area of the particular Group Award to which it contributes.

General information for centres (cont)

Assessment: This Unit should be assessed holistically with candidates producing evidence to meet the requirements for Outcomes 1, 2, 3 and 4 in a closed-book supervised assessment with a cut off score of 60% Outcome 5 is an assessment of practical skills where evidence should be recorded in the form of a checklist and /or detailed report.

Candidates must meet the level of performance specified in the Evidence Requirements for all five Outcomes to achieve this Unit.

Higher National Unit specification: statement of standards

Unit title: DNA Molecular Techniques: Theory and Practice

Unit code: DJ6X 35

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 general principles of cloning DNA

Knowledge and/or Skills

- Transformation of E.coli by plasmid vectors.
- Subcloning of DNA.
- Genomic libraries.
- General features of cloning vectors.
- Key features of expression vectors.

Evidence Requirements

A candidate's response will be judged satisfactory where the evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- demonstrate an understanding of the transformation of E.coli by plasmid vector
- describe the subcloning of a DNA fragment from a recombinant plasmid into a plasmid vector
- describe the basic principles of genomic libraries
- identify the desirable general features of a good cloning vector.
- describe the key features of expression vectors.

Evidence should be gathered using a holistic end of Unit written test under closed-book conditions, in which candidates must obtain at least 60% of the marks available in order to pass.

Assessment Guidelines

This Outcome will be assessed by a closed-book, supervised, holistic assessment for Outcomes 1, 2, 3 and 4. This assessment should take the form of a set of short answer or restricted response questions testing candidates' knowledge and understanding of the topics listed.

Higher National Unit specification: statement of standards (cont)

Unit title: DNA Molecular Techniques: Theory and Practice

Outcome 2

Describe techniques involving RNA and cDNA

Knowledge and/or Skills

- Eukaryotic genomes.
- Poly (A) $^{+}$mRNA.
- cDNA from poly (A) $^{+}$mRNA.
- cDNA libraries.

Evidence Requirements

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

- outline the complexity of higher eukaryotic genomes
- outline the isolation of poly (A) $^{+}$mRNA
- describe the synthesis of cDNA from poly (A) $^{+}$mRNA
- describe the principles and uses of cDNA libraries

Evidence should be gathered using a holistic end of Unit written test under closed-book conditions, in which candidates must obtain at least 60% of the marks available in order to pass.

Assessment Guidelines

This Outcome will be assessed by a closed-book, supervised, holistic assessment for Outcomes 1, 2, 3 and 4. This assessment should take the form of a set of short answer or restricted response questions testing candidate's knowledge and understanding of the topics listed.

Outcome 3

Describe the basic principles of PCR

Knowledge and/or Skills

- Exponential amplification
- Automated PCR
- PCR primers
- PCR cloning procedure
- Site-specific mutagenesis

Higher National Unit specification: statement of standards (cont)

Unit title: DNA Molecular Techniques: Theory and Practice

Evidence Requirements

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

- outline the basic concept of exponential amplification of defined regions of sequence
- outline the practicalities of automated PCR
- describe the general principles for the design of PCR primers
- analyse a brief case history of a PCR cloning procedure
- outline a method for site-specific mutagenesis using PCR

Evidence should be gathered using a holistic end of Unit written test under closed-book conditions, in which candidates must obtain at least 60% of the marks available in order to pass.

Assessment Guidelines

This Outcome will be assessed by a closed-book, supervised, holistic assessment for Outcomes 1, 2, 3 and 4. This assessment should take the form of a set of short answer or restricted response questions testing candidates knowledge and understanding of the topics listed.

Outcome 4

Describe the applications of molecular DNA technology and the implications to the biotechnology industry

Knowledge and/or Skills

- Applications of molecular DNA technology
- Implications of molecular DNA technology to the biotechnology industry

Evidence Requirements

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

- describe current applications of molecular DNA technology
- describe current implications of molecular DNA technology to the biotechnology industry

Evidence should be gathered using a holistic end of Unit written test under closed-book conditions, in which candidates must obtain at least 60% of the marks available in order to pass.

Higher National Unit specification: statement of standards (cont)

Unit title: DNA Molecular Techniques: Theory and Practice

Assessment Guidelines

This Outcome will be assessed by a closed-book, supervised, holistic assessment for Outcomes 1, 2, 3 and 4. This assessment should take the form of a set of short answer or restricted response questions testing candidates knowledge and understanding of the topics listed.

Outcome 5

Demonstrate practical skills in molecular biological techniques

Knowledge and/or Skills

- Isolation of nucleic acids
- Restriction enzymes
- Restriction digests
- Plasmid maps
- Gel electrophoresis

Evidence Requirements

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

- perform a DNA extraction
- understand the specificity of restriction enzymes in terms of recognition sites
- perform a restriction digestion of a plasmid
- demonstrate understanding of plasmid maps in terms of unique restriction sites
- perform gel electrophoresis of a restriction digest and interpret their results correctly
- Adhere to health and safety requirements

Evidence for this Outcome will be in the form of checklists and/or a detailed report that cover all of the points listed above. Candidates need to successfully meet all of the requirements for this Outcome in order to pass.

Assessment Guidelines

Evidence for this Outcome does not necessarily have to be generated by a single instrument of assessment. It is strongly encouraged that a number of exercises of a similar nature are utilised in order to provide multiple opportunities for generation of evidence.

Administrative Information

Unit code: DJ6X 35

Unit title: DNA Molecular Techniques: Theory and Practice

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

SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of Higher National qualifications.

Additional copies of this Unit specification can be purchased from the Scottish Qualifications Authority. Please contact the Customer Contact Centre for further details, telephone 0845 279 1000.

Higher National Unit specification: support notes

Unit title: DNA Molecular Techniques: Theory and Practice

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 80 hours.

Guidance on the content and context for this Unit

This Unit is primarily intended to provide the candidate with an understanding of the main concepts of molecular DNA technology, namely, the principles of cloning DNA including techniques using RNA and cDNA and the principles of PCR. In addition the integration of practical activities (in particular gel electrophoresis) allows the candidate to gain experience in techniques which can be used in other units.

Outcome 1 provides an overview of the general principles of cloning DNA. The emphasis here is on the transformation of E.coli by bacterial plasmid vectors. Candidates should become familiar with the following:

- Transformation: competent cells; drug selection for transformants; calculation of transformation efficiency.
- Subcloning: restriction digestion; ligation; transformation.
- Genomic libraries: fragmentation of the genome; calculations using the Clarke and Carbon equation; outline of some screening methods.
- Cloning vectors: multiple cloning sites; selective markers; screening for inserts.
- Expression vectors: sequences required for expression in E.coli; E.coli expression vectors; inducible expression; fusion proteins.

Outcome 2 looks at the techniques involving RNA and cDNA. Candidates should become familiar with the following:

- Complexity: small percentage encoding amino acid sequences; introns; exons.
- Isolation: handling RNA; poly $(A)^+$mRNA.
- Synthesis of cDNA: reverse transcriptase.
- cDNA libraries: use of linkers; outline of screening methods; antibody screening of cDNA libraries.

Higher National Unit specification: support notes (cont)

Unit title: DNA Molecular Techniques: Theory and Practice

Outcome 3 concentrates on allowing candidates to become familiar with the basic principles of PCR. Candidates should become familiar with:

- Basic concept: 2 synthetic primers*; in vitro* DNA synthesis; exponential growth.
- Practicalities: heat-stable DNA polymerase; proof reading of polymerase; automation of PCR; contamination.
- PCR primers: length; base composition; engineering restriction sites; degenerate primers.

Outcome 4 allows the candidate to become familiar with the applications of molecular DNA technology in the area of biotechnology. Candidates should become familiar with:

- Current applications: gene therapy; vaccine production; genetically modified organisms.
- Current implications to biotechnology: biological hazards of recombinant strains; containment regulations; manufacture of molecular DNA products.

Outcome 5 concentrates on allowing candidates to gain practical skills in molecular DNA technology. These skills include DNA extraction methods, restriction digests, gel electrophoresis and restriction mapping. It is important that this Outcome is used to reinforce the theoretical knowledge gained in Outcome 1. Candidates should adhere to Health and Safety requirements at all times.

Guidance on the delivery and assessment of this Unit

This Unit is designed to form part of a Group Award in a science related discipline. The Unit requires the candidate to be familiar with the main concepts of molecular DNA technology.

It is essential that this Unit is delivered in such a way as to emphasise the key points of molecular DNA technology as opposed to the minute detail. Instruments of assessment should be constructed with this in mind.

This Unit should be assessed holistically with candidates producing evidence to meet the requirements for Outcomes 1,2,3 and 4 in a single piece of work.

Outcome 5 is an assessment of practical skills where evidence should be recorded in the form of a checklist and /or lab report.

Higher National Unit specification: support notes (cont)

Unit title: DNA Molecular Techniques: Theory and Practice

Open learning

If this Unit is delivered by open or distance learning methods, additional planning resources may be required for candidate support, assessment and quality assurance.

A combination of new and traditional authentication tools may have to be devised for assessment and re-assessment 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**

General information for candidates

Unit title: DNA Molecular Techniques: Theory and Practice

This is a 2 credit HN Unit at SCQF level 8 intended for candidates undertaking an HND Biotechnology. It is designed to provide you with an introduction to some of the main concepts of molecular DNA technology.

On completion of this Unit you should be able to:

1. Describe the general principles of cloning DNA.
2. Describe techniques involving RNA and cDNA
3. Describe the basic principles of PCR..
4. Describe the applications of molecular DNA technology and the implications to the biotechnology industry.
5. Demonstrate practical skills in molecular biological techniques.

The five Outcomes that make up the Unit are described below:

Outcome 1
This Outcome looks at the general principles of cloning DNA. The lectures/tutorials for Outcome 1 will focus on bacterial plasmids and cloning vectors. You will look at the desirable features of these cloning vectors and how foreign fragments of DNA can be inserted.

Outcome 2
This Outcome focuses on the differences between prokaryotic and eukaryotic genomes. You will also study techniques involving RNA and reverse transcriptase to produce cDNA which can be used to construct cDNA libraries.

Outcome 3
In this Outcome you will be introduced to the techniques involved in PCR. You will look at the application of this technique in cloning and in mutagenesis.

Outcome 4
This Outcome focuses on the most current applications of molecular DNA technology, and demonstrates how the theory you have learned in previous Outcomes is put into practice on a large scale. You will also learn about the regulations which biotechnology companies have to consider while manufacturing recombinant DNA products.

Outcome 5
In this Outcome you will carry out practical activities that involve plasmid mapping. You will learn how to perform restriction digests and how to analyse the results of such an experiment by gel electrophoresis. This Outcome is designed to reinforce the theory taught in Outcome 1. You may be expected to produce a detailed report from your findings.

General information for candidates (cont)

Unit title: DNA Molecular Techniques: Theory and Practice

Your knowledge of the topics covered in this Unit will be tested in the form of a closed-book test covering Outcomes 1, 2, 3 and 4. Additionally, you will be required to produce evidence of having carried out practical activities for Outcome 5.

To succeed in this Unit you must achieve a satisfactory level of performance in all assessments.