Higher National Unit specification

General information

Unit title: Applied Biochemical Techniques (SCQF level 7)

Unit code: H91T 34

Superclass: RH

Publication date: May 2015

Source: Scottish Qualifications Authority

Version: 01

Unit purpose

This Unit is designed to provide learners with a practical introduction to, and an understanding of, the common techniques used in biochemical laboratories. Learners will also develop practical skills using biochemical techniques. The Unit is suitable for learners studying at HND level, and will provide the necessary underpinning knowledge and skills to enable progression to further study of practical biochemistry at degree level or employment in science based industries.

Outcomes

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

1 Explain the use of spectrophotometry as a biochemical tool.
2 Explain the use of enzyme assays as a biochemical tool.
3 Explain the use of chromatography as a biochemical tool.
4 Explain the use of electrophoresis as a biochemical tool.
5 Perform practical experiments using biochemical techniques.

Credit points and level

1 Higher National Unit credit at SCQF level 7: (8 SCQF credit points at SCQF level 7)

Recommended entry to the Unit

Entry is at the discretion of the centre, however it is recommended that learners should have completed the HN Units H92X 34 *Fundamental Chemistry: Theory and Laboratory Skills* and H922 34 *Biochemistry: Theory and Laboratory Skills*, or equivalent, or have experience of Chemistry at Higher level.

Higher National Unit specification: General information (cont)

Unit title: Applied Biochemical Techniques (SCQF level 7)

Core Skills

Opportunities to develop aspects of Core Skills are highlighted in the Support Notes for this Unit specification.

There is no automatic certification of Core Skills or Core Skill components in this Unit.

Context for delivery

If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

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

Equality and inclusion

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

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

Higher National Unit specification: Statement of standards

Unit title: Applied Biochemical Techniques (SCQF level 7)

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

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

Outcome 1

Explain the use of spectrophotometry as a biochemical tool.

Knowledge and/or Skills

- General principles of spectrophotometry
- Beer Lambert law
- Components of spectrophotometer
- Applications of spectrophotometry

Outcome 2

Explain the use of enzyme assays as a biochemical tool.

Knowledge and/or Skills

- The basic principles of enzyme kinetics
- The design of controls
- The effect of inhibitors

Outcome 3

Explain the use of chromatography as a biochemical tool.

Knowledge and/or Skills

- General principles of chromatography
- Gel filtration
- Ion exchange
- Affinity
- High Performance Liquid Chromatography (HPLC)
- Gas Chromatography (GC)

Higher National Unit specification: Statement of standards (cont)

Unit title: Applied Biochemical Techniques (SCQF level 7)

Outcome 4

Explain the use of electrophoresis as a biochemical tool.

Knowledge and/or Skills

- The principles of electrical attraction
- The concept of gel matrices
- Techniques used in visualisation and identification of molecules from a gel
- Types of electrophoresis

Outcome 5

Perform practical experiments using biochemical techniques.

Knowledge and/or Skills

- Experiments involving biochemical techniques
- Working safely, within current health and safety regulations
- Consistent and accurate results
- Recording observations and results
- Evaluation skills
- Result analysis and conclusions

Evidence Requirements for this Unit

Written and/or oral recorded evidence for Outcomes 1–4 should be assessed using a holistic closed-book assessment under supervised conditions. The assessment will use a sampling approach to the Knowledge and/or Skills as detailed below. It is recommended that the assessment be completed within one hour.

Written and/or oral recorded evidence for Outcome 5 should be assessed by production of a full laboratory report, or by completion of an appropriate pro forma. An assessor's observation checklist could be used to record performance evidence of practical experiments

Outcome 1

The assessment will sample two of the four Knowledge and/or Skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (re-sit) assessment.

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

- Explain the concept of transmission and absorption of light.
- Explain the relationship between concentration and absorbance.
- Describe the key components of a spectrophotometer.
- Describe a range of biochemical applications of spectrophotometry.

Higher National Unit specification: Statement of standards (cont)

Unit title: Applied Biochemical Techniques (SCQF level 7)

Outcome 2

The assessment will sample two of the three Knowledge and/or Skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (re-sit) assessment.

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

- Describe kinetics in terms of reaction rates, saturation, affinity and limiting factors.
- Explain the need for appropriate controls.
- Describe the mechanism of action of competitive and non-competitive inhibitors.

Outcome 3

The assessment will sample three of the six Knowledge and/or Skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (re-sit) assessment.

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

- Explain the concept of separation between a mobile and a stationary phase.
- Explain the concept of separation based on size.
- Explain the concept of separation based on charge.
- Explain the concept of separation based on affinity for a specific ligand.
- Explain the concepts of high performance liquid chromatography.
- Explain the concept of chromatography where the mobile phase is in the gaseous state.

Outcome 4

The assessment will sample two of the four Knowledge and/or Skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (re-sit) assessment.

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

- Explain the concept of polarity and the influence of pH on attraction.
- Explain the ability of a gel to separate molecules based on size and shape.
- Describe protein and nucleic acid stains/dyes and coupled antibodies.
- Describe a range of biochemical applications of electrophoresis.

Higher National Unit specification: Statement of standards (cont)

Unit title: Applied Biochemical Techniques (SCQF level 7)

Outcome 5

Learners will perform a minimum of four practical experiments, the content of which will be related to: spectrophotometry, chromatography, electrophoresis and enzyme assay. A learner's response will be judged satisfactory where the evidence shows that the learner can achieve all of the following:

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

An assessor observation checklist will be used to record the learner's performance of the practical work in line with given instructions and health and safety requirements.

Learners must report one of the four practical experiments by production of a full laboratory report. Learners may report the remaining practical experiments by production of a full laboratory report or by completion of an appropriate pro forma. Where a pro forma approach is deployed, the pro forma will not present information or assistance to the learners on how to correctly perform calculations, analyse experimental results or experimental errors. Learners will be expected to perform such activities independently on the basis of the experimental data.

Where a learner does not perform an assessed practical experiment to the required standard, they will be given the chance to either reattempt the same practical experiment, or to undertake a different practical experiment of similar complexity. Where a laboratory report or pro forma does not meet required standard, then the learner will be given a single opportunity to re-draft. If the required standard is still not attained, then an alternative practical experiment will be set.

Higher National Unit Support Notes

Unit title: Applied Biochemical Techniques (SCQF level 7)

Unit Support Notes are offered as guidance and are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

Guidance on the content and context for this Unit

This Unit is intended as part of the framework for HNC/HND Applied Sciences and HND Applied Biological Sciences but may be suitable for inclusion in other HN Science awards. It is designed to develop the underpinning knowledge and skills that are relevant to common techniques utilised in biochemical laboratories. The Unit will focus on the application of techniques via practical experiments, safety considerations and data handling/problem solving activities. The essential underpinning knowledge and skills gained will be invaluable during employment or further study.

Outcome 1 — Explain the use of spectrophotometry as a biochemical tool

This Outcome focuses on the use of spectrophotometry in biochemical analysis. Learners should become familiar with the following features:

♦ General principles: Transmission and absorption of light	definitions of T and of A, relationship between T and A, factors influencing T and A.
♦ Beer Lambert	equation, limitations of rule.
♦ Components	light source (eg deuterium), sample holder (cuvette), prism or diffraction grating and a detector (eg photocell).
♦ Applications	turbidity measurement, enzyme assays, drug testing, determination of concentration (eg DNA/RNA or dissolved carbon content).

Outcome 2 — Explain the use of enzyme assays as a biochemical tool

This Outcome requires learners to be able to explain the underlying principles of enzyme assays and their use in biochemical analysis. The Knowledge and/or Skills which should be covered are:

- Enzyme kinetics: Vmax and Km determinations could be utilised to illustrate the concepts of enzyme saturation and enzyme affinity respectively.
- Controls: the requirement for and design of appropriate controls.
- Inhibitors: changes in Vmax and Km could be used to differentiate between mechanisms of competitive and non-competitive inhibition only.

An ideal opportunity exists in this Outcome to engage learners in data-handling/problem solving activities. This could be through the production and use of Lineweaver-Burke plots to allow the determination of Km and Vmax in the presence and absence of inhibitors.

Outcome 3 —Explain the use of chromatography as a biochemical tool

This Outcome focuses on the use of chromatography in biochemical analysis. The Knowledge and/or Skills which should be covered are:

- General principles: Separation of components in a mixture. Partitioning between mobile and stationary phases.
- Gel filtration: pore size; calibration; elution.
- Ion exchange: anion and cation exchangers; salt gradients.
- Affinity: coupling; resolving power; elution.
- HPLC: pressure; resolution; mobile and stationary phases.
- GC: sample preparation; phases; resolution; sample detection.

Outcome 4 — Explain the use of electrophoresis as a biochemical tool

This Outcome focuses on the use of electrophoresis in biochemical analysis. The Knowledge and/or Skills which should be covered are:

- Electrical: attraction: polarity; effect of pH; role of buffers.
- Gel matrices: pore size; agarose; acrylamide; safety aspects.
- Visualisation and identification: coomasie blue; silver stains; ethidium bromide; enzyme-linked antibodies; autoradiography; safety aspects.
- Types: flat-bed; vertical; denaturing; non-denaturing; isoelectric; DNA sequencing; safety aspects.

Outcome 5 — Perform practical experiments using biochemical techniques

Guidance on suitable practical experiments for assessment purposes is given elsewhere in this document. However, it is envisaged that learners will also participate in a range of other practical experiments which will both develop their laboratory skills and support the theory covered in Outcomes 1–4.

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

Guidance on approaches to delivery of this Unit

There is no particular order in which Outcomes 1–4 would be best delivered. It is envisaged that laboratory work and demonstrations will feature across the delivery of each of the Outcomes, and that the assessed practical experiments for Outcome 5 will be undertaken in similar timeframe to the underpinning theory.

It is envisaged that delivery of Outcome 1 would commence with an explanation of the wave and particle concepts of light, leading to an understanding of its transmission and absorption. At this level only a very limited exposition of these theories should be given, but it is important that learners are aware of the principles of transmission and absorption and how spectrophotometers can be utilised in biochemistry to measure either parameter in order to detect and/or quantify the presence of specific materials.

Outcome 2 could build on the knowledge gained in Outcome 1 but in the specific context of enzyme assays. The emphasis in this Outcome should be on the design of enzyme assays and their application in investigating the kinetics of enzyme reactions and the mechanism of action of inhibitors, rather than on the technicalities of how the product (or substrate) of the reaction is detected.

Higher National Unit Support Notes (cont)

Unit title: Applied Biochemical Techniques (SCQF level 7)

Outcome 3 is intended to provide learners with an introduction to the key types of chromatography used in biochemical analysis. Delivery should emphasise the need to choose a technique which enables the material of interest to partition between a mobile and stationary phase based on a physical property such as charge or size. The degree of resolution should be highlighted as should limitations of each technique, as these determine the usefulness of the technique in biochemical analysis.

Outcome 4 is suitable for delivery in an experimental context which emphasises the practical applications of electrophoresis and which develops the ability to apply theoretical knowledge to practical problems. Learners could load, run and 'stain' polyacrylamide and agarose gels and relate observations to underpinning theory. The interpretation of results from pre-run gels (or images of pre-run gels) also presents an opportunity for learners to develop the skills that they will need to successfully use this biochemical tool.

It is envisaged that Outcome 5 will be delivered alongside the theoretical based Outcomes 1–4. A range of practical experiments could be utilised to both support understanding of the underlying theory and to prepare learners for undertaking the assessed practical experiments. Aspects suitable for experimental investigation should include spectrophotometry, chromatography, electrophoresis and enzyme assay.

Guidance on approaches to assessment of this Unit

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to learners.

Outcomes 1–4 could be assessed by a single holistic closed-book extended case study and/or problem solving activity that covers the sampling requirements as detailed in the Evidence Requirements. Assessment should be carried out in supervised conditions, and it is recommended that the assessment be completed within 60 minutes.

Where evidence of Outcomes 1–4 is assessed by sampling, the whole of the content listed in the Knowledge and/or Skills must be taught and available for assessment. Learners should not know in advance the items on which they will be assessed, and different items should be sampled on each assessment occasion. Any items not sampled in the first assessment, must be included in the alternative (re-sit) assessment.

In Outcome 5 learners are required to undertake four assessed practical experiments, the content of which will be related to: spectrophotometry, chromatography, electrophoresis and enzyme assay. Examples of suitable experiments are given below. However, this list is not prescriptive, and other practical experiments of similar complexity may be used by the centre.

Suitable practical experiments are:

Spectrophotometry

- Preparation of a calibration curve for quantitative determination of solutions of, for example, transition metal ions.
- Preparation of absorption spectra to identify an 'unknown' sample of, for example, the various pigments found in plant cells.

Chromatography

- Separation of organic molecules, such as parabens, by hydrophobic HPLC column.
- Separation of a mixture of dyes or proteins by standard column chromatography.

Electrophoresis

- Separation of a mixture of differently sized proteins by acrylamide gel electrophoresis.
- Separation of a mixture of differently sized nucleic acid fragments by agarose gel electrophoresis.

Enzyme assays

- Investigation of the effect of limiting factors on enzyme reactions (directly or through coupled reactions).
- Visible/UV spectrophotometry to follow the effect of inhibitors in enzyme reactions (directly or through coupled reactions).

Assessed practical experiments will usually be performed individually. However, there may be some experiments that are suitable to be undertaken in pairs or small groups. If this is the case then the assessor should ensure that all participants are actively involved and are able to adequately demonstrate the required skills.

An exemplar instrument of assessment with marking guidelines has been produced to indicate the national standard of achievement at SCQF level 7.

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

Opportunities for e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at **www.sqa.org.uk/e-assessment**.

Higher National Unit Support Notes (cont)

Unit title: Applied Biochemical Techniques (SCQF level 7)

Opportunities for developing Core and other essential skills

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

Numeracy — Using Number at SCQF level 6

Learners will be required to decide on the steps and operations to solve complex problems, and carry out sustained and complex calculations, eg performing calculations related to calculating solute concentrations based on spectrophotometry results or determining molecular weights based on elution volumes in chromatography.

Numeracy — Using Graphical Information at SCQF level 6

Learners may be required to extract, analyse, and interpret graphical information, identifying significant features in complex graphical information eg using semi-logarithmic graphs to determine molecular weight of DNA fragments or proteins in analysis of gel electrophoresis results.

Problem Solving — Reviewing and Evaluating at SCQF level 6

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

Information and Communication Technology (ICT) — Providing/Creating Information at SCQF level 6

Learners will make effective and appropriate use of ICT to access interactive learning resources such as virtual depictions of the principles involved in spectrophotometry or how enzyme inhibitors interact with the catalyst.

Working with Others at SCQF level 6

During the assessed practical experiments learners may carry out laboratory work in pairs/groups, especially where practical experiments have been integrated into a project. Learners would need to work with others to plan, agree, and take responsibility for tasks; to support co-operative working in appropriate ways; and to review the effectiveness of one's own contribution.

Communication at SCQF level 6

Learners are required to complete laboratory reports and they will have the opportunity to develop the general skill of producing well-structured communication on complex topics. When completing their laboratory reports, learners will have to present essential ideas/information and supporting detail in a logical and effective order.

Higher National Unit Support Notes (cont)

Unit title: Applied Biochemical Techniques (SCQF level 7)

Employability Skills

Learners will be able to develop employability skills throughout delivery of the Unit. These range from developing good analytical skills, skills in interpretation and practical laboratory skills.

History of changes to Unit

Version	Description of change	Date

General information for learners

Unit title: Applied Biochemical Techniques (SCQF level 7)

This section will help you decide whether this is the Unit for you by explaining what the Unit is about, what you should know or be able to do before you start, what you will need to do during the Unit and opportunities for further learning and employment.

This is a 1 credit Unit at SCQF level 7, which you are likely to be studying as part of the first year of an HND science programme. Before progressing to this Unit it would be beneficial to have completed the HN Units H92X 34 *Fundamental Chemistry: Theory and Laboratory Skills* and H922 34 *Biochemistry: Theory and Laboratory Skills*. The Unit will provide you with an introduction to some of the most common techniques utilised in biochemical laboratories, and you will have the opportunity to gain hands on experience of these techniques. On completion of this Unit you should be able to:

1 Explain the use of spectrophotometry as a biochemical tool.
2 Explain the use of enzyme assays as a biochemical tool.
3 Explain the use of chromatography as a biochemical tool.
4 Explain the use of electrophoresis as a biochemical tool.
5 Perform practical experiments using biochemical techniques.

Outcome 1

In this Outcome you will be introduced to the concept of spectrophotometry. You will focus on particular aspects such as how this technique is utilised in biochemistry. You will also learn how light travels through materials and the factors which influence this journey. You will also use spectrophotometry to record measurements which can then be used to identify or measure concentrations of an unknown compound.

Outcome 2

In this Outcome you will be asked to perform a basic enzyme assay and to display an understanding of the principles behind it. You will learn about such principles, namely; limiting factors, need for controls and effects of inhibitors.

Outcome 3

In this Outcome you will be introduced to the concept of chromatography. You will focus on some of the main types of chromatography and the basic principles behind each category. You will learn about different matrices, elution methods and detection methods. You will also separate components of a mixture either by High Performance Liquid Chromatography (HPLC) or by standard column chromatography.

Outcome 4

In this Outcome you will focus on the use of electrophoresis as a biochemical tool. The concept of separating out a mixture of molecules by this technique will be introduced and you will be required to carry out this technique in practice.

General information for learners (cont)

Unit title: Applied Biochemical Techniques (SCQF level 7)

Outcome 5

In this Outcome you will undertake practical experiments, based on the content of Outcomes 1–4.

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

Assessment

For Outcomes 1–4 you will take a holistic closed-book, end of Unit assessment.

Outcome 5 will be assessed after you have learned the necessary practical skills, and will take the form of four assessed practical experiments, for which you will report your results either in full laboratory reports, or by completion of pro forma reports.

Core Skills

Although there is no automatic certification of Core Skills in the Unit, you will have opportunities to develop the Core Skills of *Numeracy, Problem Solving, Information and Communication Technology (ICT), Working with Others* and *Communication* at SCQF level 6.