National Unit Specification: general information

UNIT Cell and Molecular Biology (Advanced Higher)

NUMBER D032 13

COURSE Biology (Advanced Higher)

SUMMARY

This unit provides the opportunity to develop knowledge and understanding, problem solving and practical abilities in the context of the structure, function and growth of prokaryotic and eukaryotic cells, structure and function of cell components, molecular interactions in cell events and applications of DNA technology. This is a component unit of Advanced Higher Biology.

OUTCOMES

1 Demonstrate knowledge and understanding related to cell and molecular biology.
2 Solve problems related to cell and molecular biology.
3 Collect and analyse information related to Advanced Higher Biology obtained by experiment.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have attained Higher Biology or Higher Human Biology. In particular, candidates should have a clear understanding of the topics covered in the units: Cell Biology (H) or Cell Function and Inheritance (H).

CREDIT VALUE

1 credit at Advanced Higher.

Administrative Information

Superclass: RH

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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 Cell and Molecular Biology (Advanced Higher)

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

OUTCOME 1

Demonstrate knowledge and understanding related to cell and molecular biology.

Performance criteria

(a) Prokaryotic and eukaryotic cells are described correctly in relation to their structure, function and growth.
(b) Cell components are described correctly in relation to their structure and function.
(c) Cell events are described correctly in relation to their molecular interactions.
(d) DNA technology is described correctly in relation to its applications.

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 cell and molecular biology.

Performance criteria

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

Evidence requirements

Evidence of an appropriate level of achievement must be generated from a closed book test with items covering all the above performance criteria with problems in the context of the structure, function and growth of prokaryotic and eukaryotic cells, structure and function of cell components, molecular interactions in cell events or applications of DNA technology.

National Unit Specification: statement of standards (cont)

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OUTCOME 3

Collect and analyse information related to Advanced Higher Biology obtained by experiment.

Performance criteria

(a) The information is collected by active participation in the experiment.
(b) The experimental procedures are described accurately.
(c) Relevant measurements and observations are recorded in an appropriate format.
(d) Recorded experimental information is analysed and presented in an appropriate format.
(e) Conclusions drawn are valid.
(f) The experimental procedures are evaluated with supporting argument.

Evidence requirements

A report of one experimental activity is required, covering the above performance criteria and related to the contents and notes specified for Advanced Higher Biology.

The teacher/lecturer responsible must attest that the report is the individual work of the candidate derived from active participation in an experiment involving the candidate in planning the experiment; deciding how it is managed; identifying and obtaining the necessary resources, some of which must be unfamiliar; and carrying out the experiment. Depending on the activity, the collection of the information may be group work.

Evidence submitted in support of attainment of PC(d) must be in the format of a table or graph(s) as appropriate. Conclusions drawn should be justified by reference to supporting evidence.

The evaluation should cover all stages of the experiment, including the initial analysis of the situation and planning and organising the experimental procedure.

National Unit Specification: support notes

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This part of the unit specification is offered as guidance. The support notes are not mandatory.

While the 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, function and growth of prokaryotic and eukaryotic cells***

i Comparison of features and ultrastructure of prokaryotic and eukaryotic cells.
ii Cell growth and the cell cycle.
Interphase: G1, S and G2 phases (G: growth, S: synthesis).
Mitosis: the M phase
Control of the cell cycle
Abnormal cell division: cancer cells.
iii Differentiation of cells into tissues and organs.
iv Cell and tissue culture.
Mammalian cell culture.
Bacterial and fungal cultures.
v Plant tissue culture.

b) ***Structure and function of cell components***

i Carbohydrates.
Structure of the monomer glucose.
Dehydration (condensation) to form 1-4 linkages between alpha and beta forms.
Polysaccharide structure.
Functions of carbohydrates: role in energy budget, storage, cell structures.
ii Lipids.
Structure of glycerol, saturated and unsaturated fatty acids.
Dehydration (condensation) of glycerol and fatty acids to form ester linkages in fats.
Triglyceride and phospholipid structure.
Structure of steroids.
Functions of lipids: structural, storage, hormones.
iii Proteins.
Structure of amino acids.
Dehydration (condensation) synthesis and peptide bonds.
Primary, secondary, tertiary and quaternary structure.
Functions of proteins. Examples to include catalytic, structural, messenger, carriers.
iv Nucleic acids.
Structure of DNA and RNA.
Functions of the enzymes polymerase and ligase.
v Membranes.
Membrane composition and organisation.
Types of membrane proteins.
Functions of membrane proteins.

vi Cytoskeleton.
Composed of fibres as illustrated by microtubules.
Function.

c) ***Molecular interactions in cell events***

i Catalysis.
Specificity of enzyme activity related to induced fit.
Control of enzyme activity by competitive and non-competitive inhibitors, enzyme modulators and covalent modifications.
Role of end-product inhibition in the control of metabolic pathways.
ii The sodium-potassium pump (a specific case of active transport).
iii Cell signalling.
Extracellular hydrophobic signalling molecules.
Extracellular hydrophilic signalling molecules.

d) ***Applications of DNA technology***

i The Human Genome Project.
Genetic linkage mapping.
Location of genetic markers to allow testing of genetic linkage to known markers.
Physical mapping.
Determination of order of genes on each chromosome.
DNA Sequencing.
Determining the order of nucleotide pairs of each chromosome.
Analysing the genomes of other species.
Comparison of the human genome with other species reveals remarkable similarities.
ii Human therapeutics.
Detecting genetic disorders.
Gene therapy: the replacement of a faulty gene with a normal gene; the insertion of an extra gene with the intention that the gene product will play a therapeutic role.
iii Forensic uses.
iv Agriculture.
Transgenic plants.
Production of bovine somatotrophin (BST) by genetic engineering and its use in cattle.

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

Outcome 2

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

- calculate mitotic index in onion root tips from photomicrographs
- design and carry out an investigation into the effects of competitive and non competitive inhibition on enzyme activity
- use computer simulation for DNA sequencing
- analyse data from gene therapy trials.

Outcome 3

Suitable experiments in the context of this unit include:

- carry out an experiment to determine the percentage glucose in prepared solutions
- carry out an experiment to compare the reaction of iodine with starch, cellulose and glycogen
- carry out an experiment to compare the solubility of lipids in a variety of solvents
- carry out an experiment to determine the isoelectric point of a protein
- design and carry out an investigation into the effects of competitive and non competitive inhibition on enzyme activity
- carry out an experiment to demonstrate gel electrophoresis of DNA treated with restriction enzymes.

Candidates or centres could devise other appropriate experiments in the context of structure, function and growth of prokaryotic and eukaryotic cells, structure and function of cell components, molecular interactions in cell events or applications of DNA technology.

The experiments chosen should allow all the performance criteria for this outcome to be achieved within any single report.

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. Opportunities to generate evidence of attainment of Outcome 3 will arise during practical work related to the suggested learning activities.

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 candidate's 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

Type of experimental activity

The teacher/lecturer should ensure that the experimental activity to be undertaken in connection with Outcome 3 affords opportunity for the candidate to demonstrate the ability to undertake the planning and organising of an experimental activity at an appropriate level of demand. The activity must relate to the Course content and candidates should be made aware of the range of skills which must be demonstrated to ensure attainment of Outcome 3.

Assessment of Outcome 3

Candidates are only required to produce one report for Outcome 3 in relation to the contents and notes specified for Advanced Higher Biology. This report can then be used as evidence for Outcome 3 for any of the other units in the course, excluding the Biology Investigation Unit.

In relation to PC (a), the teacher/lecturer checks by observation that the candidate participates in the collection of experimental information by playing an active part in planning the experiment, deciding how it will be managed, identifying and obtaining resources (some of which must be unfamiliar to the candidate), carrying out the experiment, and evaluating all stages of the experiment, including the initial analysis of the situation, and planning and organising the experimental procedures.

National Unit Specification: support notes (cont)

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Candidates should provide a report with an appropriate title. The report should relate to the performance criteria as follows:

(b)	The experimental procedures are described accurately.	A clear statement of the aim of the experiment. A few brief concise sentences including as appropriate: • a labelled diagram or brief description of apparatus or instruments used • how the independent variable was altered • control measure used • how measurements were taken or observations made There is no need for a detailed description. The use of the impersonal passive voice is to be encouraged as an example of good practice but this is not mandatory for meeting the performance criteria.
(c)	Relevant measurements and observations are recorded in an appropriate format.	Readings or observations (raw data) must be recorded in a clear table with correct headings, appropriate units and results/readings entered correctly.
(d)	Recorded experimental information is analysed and presented in an appropriate format.	Data should be analysed and presented in a tabular, graphical format or scatter diagram or equivalent, as appropriate: • for tabular presentation this may be an extension of the table used for PC (c) above, and must include: suitable heading and units showing averages or other appropriate computations • for graphical presentation this must include: data presented as a histogram, bar chart, connected points or line of best fit as appropriate, with suitable scales and axes labelled with variable and units and with data correctly plotted
(e)	Conclusions drawn are valid.	Conclusions should use evidence from the experiment and relate back to the aim of the experiment. At least one of the following should be included: • overall pattern to readings or observations (raw data) • trends in analysed information or results • connection between variables and controls
(f)	The experimental procedures are evaluated with supporting argument.	The evaluation could cover all stages of the activity including preparing for the activity, analysis of the activity and the results of the activity. The evaluation must include a supporting argument in at least one of the following: • effectiveness of procedures • control of variables • limitations of the equipment • possible sources of error • possible improvements

National Unit Specification: support notes (cont)

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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 reports

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. Excel may be used to analyse large amounts of experimental data and to plot error bars charts. 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, September 2003).