SCOTTISH QUALIFICATIONS AUTHORITY

National Unit Specification: general information

UNIT Cell Function and Inheritance (Higher)

NUMBER D043 12

COURSE Human Biology (Higher)

SUMMARY

The unit seeks to develop knowledge and understanding, problem solving and practical abilities related to the role of enzymes in cell metabolism, protein synthesis, energy transfer, cell transport, cellular response in defence and inheritance. This is a component unit of Higher Human Biology.

OUTCOMES

1 Demonstrate knowledge and understanding related to cell function and inheritance.
2 Solve problems related to cell function and inheritance.
3 Collect and analyse information related to cell function and inheritance obtained by experiment.

RECOMMENDED ENTRY

Entry to this unit is at the discretion of the centre. However, it would be an advantage if the candidate had attained one of the following:

- Standard Grade Biology with Knowledge and Understanding and Problem Solving at grades 1 or 2
- Intermediate 2 Biology

In particular, candidates should have a clear understanding of the Standard Grade Biology topics of carbohydrates, proteins, fats, cell structure, cell respiration, osmosis, enzymes, the nature of microbes and the action of antibiotics. Alternatively, candidates should have achieved the units: *Living Cells (Int 2)* and *Environmental Biology and Genetics (Int 2).*

Administrative Information

Superclass: RH

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National Unit Specification: general information (cont)

UNIT Cell Function and Inheritance (Higher)

CREDIT VALUE

1 credit at Higher.

CORE SKILLS

This unit gives automatic certification of the following:

Complete core skills for the unit	Problem Solving	H
Additional core skills components for the unit	Using Graphical Information	H

Additional information about core skills is published in *Automatic Certification of Core Skills in National Qualifications* (SQA, 1999).

National Unit Specification: statement of standards

UNIT Cell Function and Inheritance (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 function and inheritance.

Performance criteria

(b) The role of enzymes is described correctly in relation to cell metabolism.
(c) Protein synthesis is described correctly in terms of protein structure and function, and the role of DNA, RNA and cellular organelles.
(d) Energy transfer is described correctly in relation to the role and production of ATP.
(e) Cell transport is described correctly in terms of the structure and function of membranes, and the absorption and secretion of materials.
(f) Cellular response in defence is described correctly in relation to humans.
(g) Inheritance is described correctly in terms of chromosomes as vehicles of inheritance, monohybrid inheritance, and mutations and chromosome abnormalities.

Evidence requirements

Evidence of an appropriate level of achievement must be generated from a closed-book assessment with items covering all the above performance criteria.

OUTCOME 2

Solve problems related to cell function and inheritance.

Performance criteria

(b) Relevant information is selected and presented in an appropriate format.
(c) Information is accurately processed, using calculations where appropriate.
(d) Conclusions drawn are valid and explanations given are supported by evidence.
(e) Experimental procedures are planned, designed and evaluated appropriately.
(f) 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 and with problems in the context of the role of enzymes in cell metabolism, protein synthesis, energy transfer, cell transport, cellular response in defence or inheritance.

National Unit Specification: statement of standards (cont)

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OUTCOME 3

Collect and analyse information related to cell function and inheritance obtained by experiment.

Performance criteria

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

Evidence requirements

A report of one experimental activity is required, covering the above performance criteria in the context of the role of enzymes in cell metabolism, protein synthesis, energy transfer, cell transport, cellular response in defence or inheritance. 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 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.

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

National Unit Specification: support notes

UNIT Cell Function and Inheritance (Higher)

GUIDANCE ON THE CONTENT AND CONTEXT OF THIS UNIT

Outcome 1

a) **The role of enzymes in cell metabolism**

i Catalytic activity.
Enzymes as catalysts within and outwith the cell in biochemical pathways.
Inborn errors of metabolism involving absence of enzymes.

ii Factors affecting enzyme activity.
The effects of various factors on enzyme activity to include inhibition, substrate concentration and enzyme concentration.
Activation of enzymes by mineral ions, vitamins and other enzymes.

b) **Protein synthesis**

1 Protein structure and function
- i The structure of protein.
- ii A brief mention of the many functions of proteins to include: enzymes, some hormones, muscular contraction, transport of substances, antibodies and structural proteins.

2 Role of DNA, RNA and cellular organelles
- i Deoxyribonucleic acid (DNA): structure, in particular the double helix; nucleotides and bases; pairing of named bases.
- ii Ribonucleic acid (RNA): single strand structure; the replacement of thymine with uracil and of deoxyribose with ribose; the functions of mRNA and tRNA in the synthesis of proteins; triplet code; codons and anti-codons.
- iii The structure and role of the nucleus and nucleolus in RNA synthesis and transport.
- iv Ribosomes: their distribution within the cell and function in protein synthesis.

c) **Energy transfer**

The role and production of adenosine triphosphate (ATP)

i ATP as a means of transferring chemical energy
Regeneration of ATP from ADP and inorganic phosphate (Pi).

ii Glycolysis: the breakdown of glucose to pyruvic acid with a net production of ATP in the cytoplasm.

iii Krebs (citric acid, tricarboxylic acid) cycle and cytochrome system. The location of these reactions within the cristae and matrix of the mitochondrion.
Relationship of folding of inner membrane to activity of mitochondrion.
The production of ATP, carbon dioxide, hydrogen and reduced co-enzyme.

iv The distinction between anaerobic and aerobic phases of respiration with reference to location, level of ATP produced and final metabolic products.

v Carbohydrates, lipids and proteins as sources of energy within the cell.
A brief mention of the many roles of lipids within the body to include energy store, heat and nerve insulation, fat pads on feet and hands, vitamin transport and hormones.

National Unit Specification: support notes (cont)

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d) **Cell transport**

1 Structure and function of membranes
   i Structure and function of membranes as described in the fluid mosaic model.
   ii Functions of lipids and proteins within the membrane.
   iii Rough and smooth endoplasmic reticulum and Golgi apparatus in the metabolism and transport of substances for export from the cell.

2 The absorption and secretion of materials
   i Diffusion and osmosis.
   The need for a constant environment within the cell and the role of the cell membrane in maintaining this environment.
   ii Endocytosis and exocytosis.
   iii Active transport.
   The function of the cell membrane in relation to selective ion uptake and release of chemicals.

e) **Cellular response in defence**

i Recognition of self and non-self antigens as in ABO blood group system.
ii Production of antibodies and the role of blood cells.
   Production of humoral antibodies by B-lymphocytes.
   Cell-mediated response by T-lymphocytes.
iii The function of macrophages.
   Phagocytosis and the function of lysosomes.
iv Immunity.
   Innate immunity.
   Acquired immunity: natural and artificial.
   Active and passive immunity.
   Autoimmunity and allergy.
v The nature of viruses and their invasion of cells.
   Alteration of cell instructions to produce more viruses.

f) **Inheritance**

1 Chromosomes as vehicles of inheritance.
   i Genes as regions of chromosomal DNA.
   ii DNA replication, its importance and its relationship to nuclear division.
   ii The normal chromosome complement, homologous pairs, autosomes and sex chromosomes.
   iv Outline of meiosis and its significance in the production of haploid gametes.
   v The contribution of independent assortment of chromosomes and crossing over to variation in gametes.
   vi Establishment of the diploid chromosome number at fertilisation and possible variety of genotype.

2 Monohybrid inheritance
   i The pattern of inheritance of a pair of alleles where one is dominant and one is recessive.
   ii The effects of alleles exhibiting dominance, co-dominance and incomplete dominance.
   iii Possible combinations of multiple alleles.
   iv Sex-linked inheritance and the effects of the presence of genes on the X-chromosome which are not on the Y-chromosome.
   v Polygenic inheritance leading to characteristics with a normal pattern of distribution.

3 Mutations and chromosome abnormalities
  i Alteration of base type or sequence.
  ii Non-disjunction and its effects on human karyotypes.
  iii Genetic screening and counselling
    The use of family histories in determining genotypes.
    The use of karyotypes of fetal material where there is a possibility of genetic disorder.
    Risk evaluation in cases of polygenic inheritance.
    Post-natal screening for conditions which have a genetic basis.

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:

- design and carry out an investigation to measure the effect of an inhibitor on enzyme activity
- obtain information from a variety of sources on the nature of DNA and RNA and their roles in protein synthesis
- examine and interpret data on the selective uptake and release of chemicals by cells
- examine data on ABO blood grouping and interpret this data to explain transfusion incompatability
- obtain and present information on tissue transplantation
- obtain and present information on the way the HIV 1 (Human Immunodeficiency Virus) disrupts the mechanisms of the immune system
- obtain and present data on the spread of a variety of viral diseases, their history and prevention
- obtain and present information on genetic fingerprinting
- calculate the answers to genetic problems using examples such as: tongue rolling and Rhesus D-antigen; MN blood groups and sickle cell anaemia; ABO blood groups
- obtain and present information on a condition such as sickle cell anaemia or cystic fibrosis
- obtain and present information on phenylketonuria (PKU)

Outcome 3

Suitable experiments include:

- the effect of enzyme concentration on enzyme action
- dehydrogenase activity in yeast
- tests for carbohydrates
- the chemical nature of the plasma membrane
- inhibition of catechol oxidase by lead.

Candidates or centres could devise other appropriate experiments in the context of the role of enzymes in cell metabolism, protein synthesis, energy transfer, cell transport, cellular response in defence or inheritance.

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

National Unit Specification: support notes (cont)

UNIT Cell Function and Inheritance (Higher)

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

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:

(b) 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

(c) Calculations to include: percentages, averages, ratios. Significant figures and units should be used appropriately.

(d) Conclusions drawn should include some justification.

(e) 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.

(f) Candidates could make predictions and generalisations from given experimental results or, given situations, predict what the results might be.

National Unit Specification: support notes (cont)

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Outcome 3

Related to PC (a) the teacher/lecturer should check by observation that the candidate has taken part in the collection of information by experiment.

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 information is analysed and presented in an appropriate format.	Data should be analysed and presented in tabular, graphical format or as a scatter diagram or equivalent, as appropriate: • for a tabular presentation this may be an extension of the table used for PC (c) above, and must include: suitable headings and units showing averages or other appropriate computations • for a 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 supporting argument in at least **one** of the following: • effectiveness of procedures • control of variables • limitations of equipment • possible sources of error • possible improvements

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.

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 and Certification Arrangements for Candidates with Special Needs/Candidates whose First Language is not English* (SQA, 1998).