

BIOLOGY
Higher

Fifth edition - published June 2002

NOTE OF CHANGES TO ARRANGEMENTS FIFTH EDITION PUBLISHED JUNE 2002

COURSE TITLE: Biology (Higher)

COURSE NUMBER: C007 12

National Course Specification

Course Details

Assessment: section inserted which details Instruments for Internal Assessment and emphasises need for only one report for Outcome 3 being required across the course.

Some clarification to content and notes as specified below

Unit 1 Cell Biology

- b) Photosynthesis 2 photolysis and carbon fixation: (i) wording referring to photolysis clarified; Photolysis has been wrongly used interchangeably with the light dependent stage. The wording now refers to the light dependent stage of which photolysis is only part. Notes for (ii) The location and significance of carbon fixation, also now refer to ATP and hydrogen provided by the light dependent stage instead of photolysis.
- c) Energy release (iii) Krebs cycle: notes referring to acetyl-CoA corrected – acetyl CoA is not a 2C compound.
- d) Synthesis and release of proteins (iii) DNA – new insert in content reads ‘the process of DNA replication and its importance’; (iii) RNA – ‘mRNA transcription’ inserted in content.
- e) Cellular response in defence in animals and plants (ii) Cellular defence mechanisms in animals: insert in notes – ‘The problem of tissue rejection and the use of suppressors in tissue transplantation’.

Unit 2 Genetics and Adaptation

- a) Variation 3 Mutation: Note inserted – ‘when dealing with mutant alleles, candidates should be able to interpret data on gene mutation frequency’.
- b) Selection and speciation 2. Artificial selection: Note inserted for (ii) – ‘Examples to include the manufacture of insulin and human growth hormone’.
- c) Animal and plant adaptations 1. Maintaining a water balance: Plants: Note inserted for (iii) – ‘Candidates should be able to give an explanation of the effect of each adaptation’.

Unit 3 Control of Growth and Development

- a) Control of growth and development 3 Hormonal influences: Note inserted for (i) – ‘Candidates are required to be able to describe the role of thyroxine’.

NOTE OF CHANGES TO ARRANGEMENTS (cont)

COURSE TITLE: Biology (Higher)

COURSE NUMBER: C007 12

National Unit Specification:

All units

Statement of Standards

Wording Outcome 3 changed to refer to Higher Biology instead of the title of the unit.

Evidence Requirements of Outcome 3 changed to refer to the context of the report being within the content and notes specified for Higher Biology instead of within the context of each unit.

Support Notes

Guidance on Approaches to Assessment for the units includes:

- additional guidance which emphasises the need to produce only one report across the course and that a report from one unit may be used as evidence for Outcome 3 for the other units
- advice on redrafting only being required for the specific performance criterion in need of further attention
- advice on the conditions required to complete the report which indicates that reports may be completed outwith class time provided reasonable measures are taken to ensure that the report is the individual work of the candidate
- advice on the use of IT for production of the Outcome 3 report
- advice on the transfer of evidence.

National Course Specification

BIOLOGY (HIGHER)

COURSE NUMBER C007 12

COURSE STRUCTURE

The course has three 40 hour units. The units cover the following content areas:

D029 12	Cell Biology (H) <ul style="list-style-type: none">• <i>Cell Structure in Relation to Function</i>• <i>Photosynthesis</i>• <i>Energy Release</i>• <i>Synthesis and Release of Proteins</i>• <i>Cellular Response in Defence in Animals and Plants</i>	1 credit (40 hours)
D030 12	Genetics and Adaptation (H) <ul style="list-style-type: none">• <i>Variation</i>• <i>Selection and Speciation</i>• <i>Animal and Plant Adaptations</i>	1 credit (40 hours)
D031 12	Control and Regulation (H) <ul style="list-style-type: none">• <i>Control of Growth and Development</i>• <i>Physiological Homeostasis</i>• <i>Population Dynamics</i>	1 credit (40 hours)

In common with all courses, this course includes 40 hours over and above the 120 hours for the component units. This may be used for induction, extending the range of learning and teaching approaches, support, consolidation, integration of learning and preparation for external assessment. This time is an important element of the course and advice on its use is included in the course details.

In determining course content, careful thought has been given to the maintenance of progression in the course. The content list provides a suggested sequence which allows for coherent study of the subject, although other approaches are possible.

Administrative Information

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National Course Specification (cont)

COURSE Biology (Higher)

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have attained one of the following:

- Standard Grade Biology with Knowledge and Understanding and Problem Solving at Credit level
- Intermediate 2 Biology.

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 Course Specification: course details

COURSE Biology (Higher)

RATIONALE

The course provides a broad-based, integrated study of a wide range of biological topics which build on the concepts developed in the Standard Grade Biology and Intermediate 2 Biology courses. The course content represents major concepts which make biology an important and fundamental area of investigative science and provides a general basis for further study or employment in areas related to biology. In addition the course develops an understanding of the way in which biological principles can be applied to the issues facing the individual and society, and fosters in candidates positive attitudes to others and the environment. The study of biology at Higher level contributes to the candidate's general and vocational education through the acquisition of relevant biological knowledge and skills, and to the development of the more general attitudes and abilities related to the processes of science.

The course provides opportunities for candidates to acquire:

- knowledge and understanding of biological concepts, facts, ideas and techniques and the applications of biology in society and industry
- skills in problem solving
- practical abilities associated with biology
- positive attitudes such as being open-minded and being willing to recognise alternative points of view; having an interest in biology, in themselves and their environment; being aware that they can make decisions which affect the well-being of themselves, others, and the quality of their environment.

The content reflects the importance of biochemistry, molecular biology and ecological/environmental issues in modern biology, both as fundamental areas of science and as a basis for study in applied fields such as genetic engineering, immunology and population studies. Genetics and evolution and the control of development are also areas of biology where significant advances have been made. The concept of control relates to the wider issue of environmental monitoring and is highly relevant to the conservation and management of natural resources. The course concentrates on the principles underlying these key topics and indicates how understanding is being exploited.

National Course Specification: course details (cont)

COURSE Biology (Higher)

COURSE CONTENT

The Higher Biology course comprises three units, each of which has a short introduction indicating links with Standard Grade and Intermediate 2 Biology. The course provides a more thorough understanding of the basic concepts which are covered in the Standard Grade and Intermediate 2 Biology courses and further develops the Standard Grade elements and Intermediate 2 outcomes of knowledge and understanding, problem solving and practical abilities.

Knowledge and understanding

Candidates should develop the ability to recall and understand facts and principles detailed in the course statements and supplementary notes in the following tables.

Problem solving

Problem solving skills should be developed so that candidates can generally:

- select relevant information from texts, tables, charts, keys, graphs and diagrams
- present information appropriately in a variety of forms, including written summaries, extended writing, tables and graphs
- process information accurately, using calculations where appropriate
- plan, design and evaluate experimental procedures
- draw valid conclusions and give explanations supported by evidence
- make predictions and generalisations based on available evidence.

Practical abilities

Practical work is essential in providing the contexts for the development of scientific problem solving skills. Practical work is necessary to underpin theoretical work and to develop skills. It fosters familiarity with apparatus and equipment, and how it works, as a useful preparation for further study or employment. As a result of engaging in practical work, candidates can generally:

- describe experimental procedures accurately
- record relevant measurements and observations in appropriate formats
- analyse and present experimental information in appropriate formats
- draw valid conclusions
- evaluate experimental procedures with supporting argument.

The following tables contain the content and suggested learning activities through which knowledge and understanding, problem solving and practical abilities are to be developed. The content statements and the supplementary notes which provide amplification, and give an indication of depth of treatment, are required for the purpose of assessment.

National Course Specification: course details (cont)

COURSE Biology (Higher)

UNIT 1 Cell Biology (Higher)

Introduction

The biochemical reactions taking place within the individual living cell are fundamental to the functioning of the whole organism. It is desirable that candidates should acquire an overall understanding of cells as functional living units. The great variety of cell structure to be found reflects the functional demands placed on cells. Organelles are introduced only where a knowledge of their structure is essential in order to understand their function.

It is important that basic concepts are not lost in dealing with the mechanisms of photosynthesis and respiration, namely that:

- each major biochemical conversion is accomplished by a sequence of reactions, each of which is catalysed by a specific enzyme; these sequences form metabolic pathways and are found in all types of cells
- in metabolic pathways, oxidation and reduction of substrates are most frequently accomplished by the removal or addition of hydrogen; oxidation of substrates releases energy and the reduction of substrates requires the consumption of energy
- the regeneration of ATP (adenosine triphosphate) from ADP (adenosine diphosphate) and Pi (Inorganic phosphate) is a major function of photosynthesis and respiration; the ATP regenerated is utilised in other cellular processes during which it is converted to ADP and Pi.

The approach to photosynthesis and respiration should aim to establish the ideas of fixation of energy and its orderly release. Care should be taken to avoid stressing the chemical complexity of each and the use of biochemical terminology should be minimised. It will be sufficient to account for the number of carbons in the cycles without reference to named intermediate compounds, other than those specifically mentioned below.

Where hydrogen is mentioned in photosynthesis and respiration, it should be made clear that it is not atomic or molecular hydrogen, but temporarily bound to a reduced coenzyme.

Candidates undertaking this unit should have a clear understanding of the following areas from Standard Grade Biology:

Topic 1 The World of Plants: photosynthesis.

Topic 3 Animal Survival: carbohydrates; proteins; fats.

Topic 4 Investigating Cells: cell structure; cell respiration; osmosis; enzymes.

Topic 5 The Body In Action: anaerobic respiration.

Topic 7 Biotechnology: fermentation.

Alternatively, candidates should have achieved the unit *Living Cells (Int 2)*.

National Course Specification: course details (cont)

Unit 1: Cell Biology (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>a) Cell structure in relation to function</p> <p>i Cell variety.</p> <p>The concept of variation in structure between cells of one type of tissue and between cells of different types of tissue.</p> <p>The existence of unicellular organisms.</p> <p>The relationship of structure to function.</p> <p>ii Absorption and secretion of materials.</p> <p>Diffusion and osmosis as basic cell processes. The role of the cell wall and plasma membrane in relation to these processes.</p> <p>Cell wall: reference to cellulose fibres and permeability.</p>	<p>In covering the concepts of cell variety and function, reference should be made to the variety of cell and tissue types encountered in Standard Grade and in Intermediate 2 Biology.</p> <p>Diffusion and osmosis can be covered at an elementary level by considering the tendency for water to diffuse from a solution of high water concentration to one of lower water concentration. Animal cells will burst in hypotonic solutions and shrink in hypertonic solutions. Plant cells will become turgid in hypotonic solutions and flaccid/plasmolysed in hypertonic solutions. The terms osmotic pressure, osmotic potential and water potential need not be used.</p>	<p>Examine prepared slides of both plant and animal tissue.</p> <p>Design and carry out an investigation to measure the water concentration of cell sap using plant tissue.</p>

National Course Specification: course details (cont)

Unit 1: Cell Biology (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>Plasma membrane: reference to fluid mosaic model.</p> <p>Function of plasma membrane in relation to selective ion uptake (active transport) and absorption and release of chemicals.</p> <p>b) Photosynthesis</p> <p>1 The role of light and photosynthetic pigments.</p> <p>i Absorption, transmission and reflection of light by a leaf.</p>	<p>In dealing with the fluid mosaic model, the essential structural features, which should be emphasised, are the protein and phospholipid composition of the membrane as well as its porous and fluid nature.</p> <p>Study of the absorption spectrum of chlorophyll should establish that absorption occurs primarily in the blue and red regions. Mention should be made of the action spectrum and its relation to the absorption spectrum of each photosynthetic pigment. Accessory pigments absorb some light from other regions of the spectrum and pass the energy on to the chlorophyll. Some of the light energy may then be used in the regeneration of ATP and also in the splitting of water.</p>	<p>Carry out an investigation into the chemical nature of the plasma membrane using, eg beetroot tissue.</p> <p>Examine published electron micrographs of plasma membranes.</p> <p>Examine and interpret data concerning solute concentrations in aquatic organisms and their environment.</p> <p>Examine the absorption and action spectra of chlorophyll and other photosynthetic pigments.</p>

National Course Specification: course details (cont)

Unit 1: Cell Biology (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>ii Role of chlorophyll and other photosynthetic pigments.</p> <p>iii Separation of photosynthetic pigments by means of chromatography.</p> <p>2 The light dependent stage and carbon fixation.</p> <p>The detailed structure of chloroplasts should be related to the stages of photosynthesis.</p> <p>i The location and significance of the light dependent stage.</p> <p>The production of ATP and hydrogen (for use in carbon fixation).</p>	<p>Mention should be made of the pigments chlorophyll a and b, xanthophyll and carotene.</p> <p>Photolysis of water results in the release of oxygen as a by-product together with hydrogen which is transferred by the hydrogen acceptor (NADP).</p>	<p>Carry out an investigation into the separation of photosynthetic pigments by means of paper chromatography or thin layer chromatography.</p> <p>Examine published electron micrographs of chloroplasts.</p>

National Course Specification: course details (cont)

Unit 1: Cell Biology (*Higher*)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>ii The location and significance of carbon fixation (Calvin cycle).</p> <p>The production of glucose as a result of an enzyme-controlled sequence of reactions requiring ATP, hydrogen (from photolysis) and carbon dioxide.</p>	<p>Coverage of the Calvin cycle should be done in such a way that the number of carbons is accounted for throughout the cycle with indications of the position of entry of (a) carbon dioxide which is accepted by the 5-carbon compound ribulose 1,5-bisphosphate (RuBP) and (b) hydrogen which is accepted by the 3-carbon compound glycerate 3-phosphate (GP). It should be stressed that these reactions, which require ATP and hydrogen provided by the light dependent stage, essentially involve the reduction of carbon dioxide to form carbohydrate.</p> <p>Candidates are not required to name intermediate chemical compounds except GP (PGA) and RuBP (RuDP).</p> <p>Mention should be made of the fact that the major biological molecules in plants (eg proteins, fats, carbohydrates, nucleic acids) are derived from the photosynthetic process.</p>	<p>Analyse data on limiting factors affecting photosynthesis.</p>

National Course Specification: course details (cont)

Unit 1: Cell Biology (*Higher*)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>c) Energy release</p> <p>The role and production of ATP.</p> <p>i Importance of ATP as a means of transferring chemical energy. The role of ATP in cellular processes. Regeneration of ATP from adenosine diphosphate (ADP) and inorganic phosphate (Pi).</p> <p>ii Glycolysis.</p> <p>The breakdown of glucose (6C) to pyruvic acid (3C) with a net production of ATP.</p> <p>Location of process within the cytoplasm.</p>	<p>Respiration should be seen as a series of reactions in which 6-carbon glucose is oxidised to form carbon dioxide. This is accompanied by the synthesis of ATP from adenosine diphosphate (ADP) and inorganic phosphate (Pi).</p> <p>The first main stage, glycolysis, which does not require oxygen, should be represented as a process in which the 6-carbon sugar is broken down step by step to form two 3-carbon pyruvic acid units giving a net gain of two ATP molecules as well as hydrogen in the form of NADH. Brief reference should be made to fats and proteins as alternative respiratory substrates.</p>	

National Course Specification: course details (cont)

Unit 1: Cell Biology (*Higher*)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>iii Krebs (Tricarboxylic acid, Citric acid) cycle.</p> <p>The production of carbon dioxide and hydrogen.</p>	<p>The aerobic phase, the Krebs cycle, can be considered as a process which begins when a 2-carbon acetyl group derived from pyruvic acid joins with coenzyme A (CoA) to form acetyl – CoA. Acetyl – CoA reacts with a 4-carbon compound to form a 6-carbon compound (citric acid). Citric acid is gradually converted, in a cyclic series of reactions, back to the 4-carbon compound, the carbons being lost as carbon dioxide. Other intermediates need not be named, but the number of C atoms in compounds in succeeding stages should be accounted for. The production of hydrogen and its transfer to the cytochrome system, resulting in formation of ATP and eventual formation of water, should be emphasised.</p>	<p>Demonstrate use of simple respirometer to measure rate of respiration.</p>

National Course Specification: course details (cont)

Unit 1: Cell Biology (*Higher*)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>iv The cytochrome system.</p> <p>The production of ATP and water.</p>	<p>The role of oxygen in the aerobic phase should be related to the cytochrome system in that, in the oxidation of pyruvic acid, hydrogens which are removed are passed through a series of carriers and finally are received by oxygen to form water. If this oxygen is not present to act as the final acceptor, the hydrogen cannot pass through the system and complete oxidation cannot take place. This system of hydrogen carriers should be seen as the most important means of releasing energy in respiration. NAD is the only named carrier which should be known. It should be made clear that energy may be released from a few individual steps in the overall process, but that most of the energy is made available by the cytochrome system.</p>	<p>Design and carry out an investigation to show the activity of dehydrogenase enzymes in yeast.</p>
<p>v Mitochondrion structure.</p>	<p>Make specific reference to cristae and central matrix and their associated biochemical reactions.</p>	<p>Examine published electron micrographs of mitochondria.</p>
<p>vi Distinction between aerobic and anaerobic phases of respiration with reference to the level of ATP production and final metabolic products.</p>		

National Course Specification: course details (cont)

Unit 1: Cell Biology (*Higher*)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>d) Synthesis and release of proteins</p> <p>The role of DNA, RNA and cellular organelles:</p> <ul style="list-style-type: none"> i The functional variety of proteins. ii DNA: structure, in particular the double helix, nucleotides and bases; pairing of named bases; genes as regions of chromosomal DNA; the process of DNA replication and its importance. iii RNA: single strand structure; replacement of thymine with uracil and deoxyribose with ribose; mRNA transcription; functions of mRNA and tRNA in synthesis of proteins; triplet code; codons and anti-codons. 	<p>The importance of the amino acid sequence to the structure and function of proteins should be emphasised. Proteins can be classified as either fibrous (eg collagen) or globular (eg enzymes, some membrane proteins, some hormones and antibodies).</p>	<p>Obtain information from a variety of sources on the nature of DNA and RNA and their roles in protein synthesis. Sources may include appropriate models, computer simulations and published materials.</p> <p>Isolate DNA from plant tissue.</p>

National Course Specification: course details (cont)

Unit 1: Cell Biology (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>iv Cellular organelles: ribosomes and rough endoplasmic reticulum. Distribution within the cell and function as site of translation in protein synthesis; role of endoplasmic reticulum in transporting proteins; role of Golgi apparatus in processing molecules for secretion.</p> <p>e) Cellular response in defence in animals and plants</p> <p>i The nature of viruses and their invasion of cells.</p> <p>Alteration of cell instructions to produce more viruses.</p> <p>ii Cellular defence mechanisms in animals.</p> <p>Phagocytosis.</p> <p>Antibody production.</p>	<p>Candidates should know that viruses are very small and that they contain DNA or RNA surrounded by a coat which is usually protein. They can alter cell metabolism so that replication of viral DNA/RNA can take place, resulting in the release of large numbers of viruses.</p> <p>The importance of lysosomes in phagocytosis should be noted. Reference need not be made to different types of phagocytes.</p> <p>The production of antibodies by lymphocytes, and antibody action in response to the presence of foreign antigens, should be given simple treatment without reference to specific types of lymphocytes or to antigen-antibody reactions.</p> <p>The problem of tissue rejection and the use of suppressors in tissue transplantation.</p>	<p>Examine published electron micrographs of ribosomes, rough endoplasmic reticulum and Golgi apparatus.</p> <p>Obtain and present information on tissue transplantation including the problem of tissue rejection and the use of suppressors.</p>

National Course Specification: course details (cont)

Unit 1: Cell Biology (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
iii Cellular defence mechanisms in plants.	Plants can protect themselves by producing a variety of toxic compounds (to include tannins, cyanide and nicotine) or by isolating injured areas by means of substances such as resin.	Analyse data on palatability of cyanogenic and non-cyanogenic clover to herbivores.

National Course Specification: course details

COURSE Biology (Higher)

UNIT 2 Genetics and Adaptation (Higher)

Introduction

This unit reinforces and extends the basic concepts and ideas established in Standard Grade Biology and in the *Environmental Biology and Genetics (Int 2)* unit. Sources of variation are examined, namely: independent assortment, crossing over and mutation. The concept of natural selection, which is by far the most important factor in evolution, leads to an understanding of the idea of speciation. Artificial selection has been so successful in producing superior strains that there is a need to conserve traditional varieties. The content of genetic engineering takes account of the Standard Grade topic of Biotechnology. The examination and interpretation of data provide evidence to support the concepts of selection and speciation. Evolution is introduced as a continuing process and the various causal factors are explained.

Organisms are faced with many problems such as maintaining a water balance, obtaining food and coping with dangers. Animals and plants have different ways of dealing with these problems due, in the main, to their fundamental differences. eg sessility or mobility.

A recurring theme is the extent to which both plants and animals are adapted physiologically, structurally and behaviourally for survival and continuation of the species.

Candidates undertaking this unit should have a clear understanding of the following areas from Standard Grade Biology:

- Topic 2 The World of Plants: effect of environmental conditions on plants; transport systems in plants, gas exchange in plants; photosynthesis.
- Topic 3 Animal Survival: kidney structure and function; effects of environmental factors on behaviour.
- Topic 4 Investigating Cells: cell division and mitosis.
- Topic 6 Inheritance: chromosomes; genes.
- Topic 7 Biotechnology: control by chromosomes.

Alternatively, candidates should have achieved the units: *Living Cells (Int 2)*, *Environmental Biology and Genetics (Int 2)* and *Animal Physiology (Int 2)*.

National Course Specification: course details (cont)

Unit 2: Genetics and Adaptation (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>a) Variation</p> <p>1 Meiosis and the dihybrid cross.</p> <p>i Sexual reproduction as a means of enabling genetic variation to be maintained in the population and its importance in long-term evolutionary change.</p> <p>ii Outline of meiosis: haploid gamete production.</p> <p>Crossing over and independent assortment of chromosomes during meiosis: a means of producing new phenotypes.</p> <p>iii The dihybrid cross: expected F₂ phenotypic ratios.</p> <p>2 Linkage and crossing over.</p> <p>i The existence of linked genes and their effect on the F₂ generation.</p>	<p>In meiosis, the following terms should be used: 1st and 2nd meiotic division, gamete mother cell, chromosome, chromatid, chiasmata, homologous. The names of the meiotic stages do not need to be known.</p>	<p>Examine suitably prepared plant and animal material to show the various stages of meiosis.</p> <p>Design and carry out an investigation to examine the phenotypes arising from dihybrid crosses.</p> <p>Obtain and interpret information relating to linkage from examination of appropriate material, eg <i>Drosophila</i>, corn-cobs.</p>

National Course Specification: course details (cont)

Unit 2: Genetics and Adaptation (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>Comparison of the distance between linked genes and the frequency of recombination.</p> <p>ii Crossing over of genes at chiasmata during meiosis resulting in recombinant gametes.</p> <p>Separation of linked genes as a source of variation.</p> <p>iii Sex linkage.</p> <p>3 Mutation.</p> <p>i Characteristics of mutant alleles, to include random occurrence and low frequency.</p> <p>ii Mutagenic agents.</p>	<p>When dealing with recombination frequencies, candidates should be able to map the relative location of up to four genes on a chromosome given the percentage recombination frequencies. The calculation of recombination frequencies from raw data is not required.</p> <p>The sex chromosomes should be represented by the symbols X and Y and the alleles by the appropriate upper and lower case superscripts, for example $X^R X^R$, $X^r X^r$, $X^R X^r$, $X^R Y$, $X^r Y$.</p> <p>When dealing with mutant alleles, candidates should be able to interpret data on gene mutation frequency.</p> <p>Mutation rate can be increased artificially by chemical agents or irradiation.</p>	

National Course Specification: course details (cont)

Unit 2: Genetics and Adaptation (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>iii Changes in the number of chromosomes through non-disjunction.</p> <p>iv Polyploidy: advantages in crop production.</p> <p>v Change in the structure of one chromosome (duplication, translocation, deletion, inversion).</p> <p>vi Alteration of base type or sequence (substitution, insertion, deletion, inversion).</p>	<p>In dealing with polyploidy, the terms triploid and tetraploid need not be known. It will be sufficient for candidates to know that polyploidy is a condition in which an individual possesses one or more sets of chromosomes in excess of the normal diploid number. In crop plants this often confers increased vigour.</p> <p>The effect of gene mutations on amino acid sequences should be noted.</p>	<p>Examine photographs of human karyotypes including Down's Syndrome.</p> <p>Obtain and interpret information relating to mutation from the examination of appropriate material, for example normal/spelt wheat, popcorn/podcorn cobs, normal/albino mice.</p> <p>Analyse information on sickle cell anaemia.</p> <p>View and discuss information obtained from computer simulation.</p>

National Course Specification: course details (cont)

Unit 2: Genetics and Adaptation (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>b) Selection and speciation</p> <p>1 Natural selection.</p> <p>i The survival of those organisms best suited to their environment.</p> <p>ii The concept of the species.</p> <p>iii The importance of isolating mechanisms as barriers to gene exchange leading to evolution of new species.</p> <p>iv Adaptive radiation.</p> <p>v The high-speed evolution of organisms such as antibiotic resistant bacteria and the melanic peppered moth.</p> <p>vi The conservation of species through wildlife reserves, captive breeding and cell banks. The maintenance of genetic diversity.</p>	<p>In the evolution of new species, the effects of isolating mechanisms, mutations and selection on the gene pool should be covered.</p>	<p>Examine data on species of animals and flowering plants endemic to Scotland.</p> <p>Examine maps to show the distribution of organisms between different continents.</p> <p>Obtain and present information on the distribution of British buttercup species.</p> <p>Obtain and present information on heavy metal resistance in grasses, calcicole/calcifuge pairs in <i>Viola</i> species or the bladder champions.</p> <p>Analyse and interpret current data on distribution of peppered moths.</p>

National Course Specification: course details (cont)

Unit 2: Genetics and Adaptation (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>2 Artificial selection.</p> <p>i The evolution of a wide variety of crops and domesticated animals through selective breeding and hybridisation as undertaken by humans.</p> <p>ii The contribution of genetic engineering to the development of new varieties.</p> <p>iii Somatic fusion in plants to produce new species.</p>	<p>In genetic engineering, the importance of being able to locate genes or groups of genes on chromosomes must be known. This can be done by gene probes or by the recognition of characteristic banding patterns. Once located, endonuclease enzymes are used to cut DNA fragments and ligase enzymes are used to seal new genes into the genome of other organisms such as bacteria. Examples to include the manufacture of insulin and human growth hormone.</p> <p>Somatic fusion is used to overcome sexual incompatibility between plant species. The technique involves the removal of the cell walls by the action of cellulase enzyme so that protoplasts can be fused.</p>	<p>Examine information on artificial selection in, eg <i>Brassica oleracea</i>, cattle, dogs.</p> <p>Analyse information on selective breeding by means of suitable computer simulation.</p> <p>Prepare and examine plant protoplasts.</p>

National Course Specification: course details (cont)

Unit 2: Genetics and Adaptation (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>c) Animal and plant adaptations</p> <p>1 Maintaining a water balance.</p> <p>Animals</p> <p>i Osmoregulation in freshwater fish and saltwater bony fish.</p> <p>ii Adaptations associated with salmon and eel migration.</p> <p>iii Water conservation in a desert mammal.</p>	<p>The study of osmoregulation in fish should include reference to the number and size of glomeruli, the filtration rate and the role of the chloride secretory cells of the gills.</p> <p>Some distinction should be made between physiological adaptations and behavioural adaptations as shown by the desert rat.</p>	<p>Obtain and present information about osmoregulation in freshwater and saltwater bony fish.</p> <p>View and discuss audio-visual material on the migration of the salmon or the eel.</p> <p>Obtain and present information about osmoregulation in a desert mammal.</p>

National Course Specification: course details (cont)

Unit 2: Genetics and Adaptation (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>Plants</p> <p>i The transpiration stream.</p> <p>ii Stomatal mechanism.</p> <p>iii Adaptations in xerophytes and hydrophytes.</p>	<p>The study of transpiration should include reference to the movement of water from the soil through the root hairs, cortex and xylem to the leaves and thence to the atmosphere without mention of the endodermis or Casparian strip. Mention should be made of different factors affecting the rate of transpiration. The concept of cohesion and adhesion of water molecules should be dealt with briefly. The uptake and transport of nutrient ions and the cooling effect of the evaporation of water from the leaves should also be considered.</p> <p>The opening and closing of stomata should be explained in terms of changes in turgor. The underlying mechanism need not be explained.</p> <p>Candidates should be able to give an explanation of the effect of each adaptation.</p>	<p>Design and carry out an investigation to compare transpiration rates.</p> <p>Carry out an investigation into stomatal opening and closing using <i>Commelina communis</i>.</p>

National Course Specification: course details (cont)

Unit 2: Genetics and Adaptation (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>2 Obtaining food.</p> <p>Animals</p> <p>i Foraging behaviour and search patterns in animals.</p> <p>ii Economics of foraging behaviour.</p> <p>iii Examples of interspecific and intraspecific competition arising from scarcity of resources.</p>	<p>The different strategies employed by plants and animals, with respect to sessility and mobility, should be noted. Candidates should appreciate the fact that energy is expended in searching for food and that, if the energy gained is less than the energy expended, this is not economical. Behaviour must be organised to maximise energy gain.</p>	<p>Carry out an investigation into planarian activity in the presence or absence of food.</p> <p>Demonstrate the economics of foraging behaviour using a game simulation.</p>

National Course Specification: course details (cont)

Unit 2: Genetics and Adaptation (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>iv Dominance hierarchy and co-operative hunting within the social group.</p> <p>v Territorial behaviour in relation to competition for food.</p> <p>Plants</p> <p>i Comparison of the sessility of plants and the mobility of animals.</p> <p>ii Competition in plants mainly for light and soil nutrients.</p> <p>iii The effect of grazing by herbivores on species diversity.</p> <p>iv Comparison of the compensation point in sun and shade plants.</p>	<p>Co-operative hunting behaviour may benefit the subordinate animal as well as the dominant, as the subordinate animal may gain more food than by foraging alone; also food sharing will occur as long as the reward for sharing exceeds that for foraging individually.</p>	<p>List examples of dominant and subordinate responses in selected animals.</p> <p>View and discuss audio-visual material on territorial behaviour and co-operative hunting.</p> <p>Carry out an investigation into the growth of plants, eg barley or cress under different conditions, eg density or nutrient levels.</p> <p>Compare the response of leaf discs from sun and shade plants to green light.</p>

National Course Specification: course details (cont)

Unit 2: Genetics and Adaptation (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>3 Coping with dangers.</p> <p>Animals</p> <p>i Avoidance behaviour and habituation.</p> <p>ii Learning as a long-term modification of response.</p> <p>iii Individual and social mechanisms for defence.</p> <p>Plants</p> <p>i Structural defence mechanisms.</p> <p>ii Ability to tolerate grazing.</p>	<p>The protective value of habituation as a short-term modification of response.</p> <p>Learning as a long-term modification should be noted. Examples of learned behaviour should be taken from natural situations and not the artificial situations of maze running and Skinner boxes. No mention need be made of trial and error learning, conditioning, latent and insight learning.</p> <p>It should be noted that because plants are sessile they must employ different strategies to animals for defence.</p> <p>Examples of structural defence mechanisms should include stings, thorns and spines.</p> <p>Some plants are able to tolerate grazing by having low meristems, deep root systems or underground stems.</p>	<p>Carry out an investigation into the escape response, including habituation, of a suitable organism.</p> <p>View and discuss audio-visual material on learning in natural situations.</p> <p>Carry out an investigation to produce learning curves in humans.</p> <p>View and discuss audio-visual material on social grouping for defence.</p> <p>Carry out an investigation on the relationship of the number of spines on holly leaves to the height above the ground.</p>

National Course Specification: course details (cont)

COURSE Biology (Higher)

UNIT 3 Control and Regulation (Higher)

Introduction

Questions related to the growth and development of organisms are central to all of modern biology: they range from the molecular control of cell differentiation to the effects of environmental factors on whole organism development. Thus a main aim of this unit is to establish the idea that the developing phenotype is the product of the effects of both internal and external factors acting on the genotype.

At the organism and population levels, systems which respond to change have evolved. These can make appropriate adjustments to ensure that conditions are normally maintained with some degree of tolerance. Such regulation is an essential component of biological systems and maximises the utilisation of resources such as energy. The linking together of regulation within organisms and populations is deliberate and serves to emphasise the biological concepts of inter-relationship and inter-dependence.

Candidates undertaking this unit should have a clear understanding of the following areas from Standard Grade Biology:

- Topic 1 The Biosphere: abiotic factors; ecosystems; feeding relationships; energy flow; population growth: controlling factors; control and management of ecosystems.
- Topic 3 Animal Survival: water balance; kidney structure and function; the need for food.
- Topic 4 Investigating Cells: mitosis; diffusion; osmosis; enzyme activity.
- Topic 6 Inheritance: variation; nature of inheritance; monohybrid crosses; fertilisation and chromosome number; sex determination.
- Topic 7 Biotechnology: applications of genetic engineering.

Alternatively, candidates should have achieved the units: *Living Cells (Int 2)*, *Environmental Biology and Genetics (Int 2)* and *Animal Physiology (Int 2)*.

National Course Specification: course details (cont)

Unit 3: Control and Regulation (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>a) Control of growth and development</p> <p>1 Growth differences between plants and animals.</p> <p>i Position and activity of meristems in plants, absence of meristems in animals.</p> <p>ii Formation of annual rings.</p> <p>iii Regeneration in angiosperms and mammals.</p> <p>iv Growth patterns in plants, and animals to include an annual plant, a tree, a human and a locust.</p> <p>2 Genetic control.</p> <p>i An introduction to the Jacob-Monod hypothesis of gene action in bacteria.</p>	<p>Whilst dealing with the formation of annual rings reference need only be made to the differences between spring and summer xylem vessels. No reference need be made to cork cambium or medullary rays.</p> <p>Angiosperms have extensive powers of regeneration. Mammals have limited powers of regeneration.</p> <p>The Jacob-Monod hypothesis should be illustrated with respect to lactose metabolism in <i>Escherichia coli</i>. The terms repressor molecule, regulator gene, inducer, operator and structural gene should be known.</p>	<p>Examine prepared slides of meristems.</p> <p>Examine annual rings.</p> <p>Obtain and present information on growth patterns in a variety of organisms including an annual plant, a tree, a human and a locust.</p> <p>Carry out an investigation into the effects of β-galactosidase enzyme on lactose in milk.</p>

National Course Specification: course details (cont)

Unit 3: Control and Regulation (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>ii The part played by genes in controlling metabolic pathways as shown in the case of phenylketonuria.</p> <p>iii The control of cell differentiation by switching particular genes on or off.</p> <p>3 Hormonal influences.</p> <p>i Pituitary hormones.</p> <p>The role of the pituitary gland in the control of growth and development involving human growth hormone (GH) and thyroid stimulating hormone (TSH).</p> <p>ii Plant growth substances.</p> <p>As exemplified by indole acetic (IAA) and gibberellic acid (GA).</p> <p>Sites of production of IAA. Effects of IAA at cellular and organ levels; role in apical dominance, leaf abscission and fruit formation.</p>	<p>A knowledge of the names of the particular conditions which result from over or underactivity of the thyroid gland and the pituitary gland is not required. Candidates are required to be able to describe the role of thyroxine.</p>	<p>Obtain and present information on the nature and occurrence of phenylketonuria.</p> <p>Design and carry out an investigation to compare the effects of different concentrations of a plant growth substance on plant growth.</p> <p>Carry out an investigation into the effects of IAA on root growth in mustard seedlings.</p>

National Course Specification: course details (cont)

Unit 3: Control and Regulation (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>Effects of GA on dormancy and in dwarf varieties of plants.</p> <p>Role of GA in α-amylase induction in barley grains.</p> <p>Practical applications of plant growth substances as illustrated by herbicides and rooting powders.</p> <p>4 Environmental influences.</p> <p>i The importance of individual macro-elements.</p> <p>Symptoms of deficiency of nitrogen, phosphorus, potassium and magnesium in plants.</p>	<p>The induction of α-amylase in the aleurone layer of barley grains provides a model of hormone action. The growth substance GA is produced at one site, the embryo, and is active at another site, the aleurone layer; only a low concentration is required to induce an effect.</p> <p>Mention should be made of the requirement for nitrogen in amino acid synthesis. Phosphorus is found in compounds such as DNA and ATP, while potassium is important in membrane transport. Magnesium is present in the chlorophyll molecule.</p>	<p>Demonstrate the effects of GA on bud dormancy: eg horse-chestnut, or potato tuber.</p> <p>Carry out an investigation on the induction of α-amylase in barley grains.</p> <p>Demonstrate the effect of commercial rooting powders on stem cuttings.</p> <p>Demonstrate water culture experiments using cereal seedlings or <i>Lemna</i>.</p> <p>Carry out an investigation into the effects of different concentrations of minerals on plant growth.</p>

National Course Specification: course details (cont)

Unit 3: Control and Regulation (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>The importance of iron and calcium in animals.</p> <p>The inhibiting effect of lead on enzyme activity.</p> <p>ii The effect of vitamin D deficiency in humans.</p> <p>iii The effect of drugs on fetal development: thalidomide, alcohol, nicotine.</p> <p>iv Light.</p> <p>The effect of light on vegetative shoot growth and development.</p> <p>The effect of light on flowering in long-day and short-day plants.</p> <p>The effect of light on the timing of breeding in birds and mammals.</p>	<p>In animals, iron is a component of haemoglobin, many enzymes and hydrogen carrying systems. Calcium is an essential component of shells, bones and teeth and is needed for blood clotting.</p> <p>Deficiency in vitamin D leads to rickets as a result of poor calcium absorption in the intestine.</p> <p>Thalidomide can cause limb deformation. Alcohol and nicotine can retard growth and mental development.</p> <p>Brief reference only need be made to phototropism and etiolation.</p> <p>In dealing with photoperiodism in flowering plants, no reference need be made to phytochrome or florigen.</p> <p>Photoperiodism in animals should not include reference to the detection centres or to the hormones involved.</p>	<p>Carry out an investigation into the inhibition of catechol oxidase by lead.</p> <p>Analyse data on the effect of alcohol or nicotine on birthweight.</p>

National Course Specification: course details (cont)

Unit 3: Control and Regulation (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>b) Physiological homeostasis</p> <p>The principle of negative feedback:</p> <ul style="list-style-type: none"> i The need to maintain conditions within tolerable limits. ii Water content of blood and concentration of cell chemicals. iii Glucose and energy needs of tissue. iv Temperature: the importance of temperature to enzyme-controlled metabolic processes in the body. v Endotherms and ectotherms. 	<p>Endocrine glands need not be discussed in detail but the central role of hormones (originating in named, specific glands) should be mentioned, namely ADH, insulin, glucagon, adrenaline.</p> <p>The role of the pituitary gland and anti-diuretic hormone (ADH); the osmotic withdrawal of water from the kidney tubule.</p> <p>The liver as a reservoir of stored carbohydrate; roles of insulin, glucagon and adrenaline in maintenance of blood sugar.</p> <p>The role of the hypothalamus as a temperature monitoring centre; nerve communication between the hypothalamus and effectors; the skin and its role in temperature regulation in mammals.</p> <p>Endotherms derive most of their body heat from their own metabolism. Ectotherms derive most of their body heat from their surroundings.</p>	<p>Analyse data on kidney function.</p> <p>Obtain and present information on blood sugar concentrations in diabetic and non-diabetic humans.</p> <p>Carry out an investigation into human body responses to sudden heat loss where visible changes and compensatory temperature change can be detected on the skin of the hand using a thermistor.</p>

National Course Specification: course details (cont)

Unit 3: Control and Regulation (Higher)

CONTENT	NOTES	LEARNING ACTIVITIES
<p>c) Population dynamics</p> <p>Regulation of plant and animal populations:</p> <ul style="list-style-type: none">i Population fluctuations: the relative stability of populations, despite short-term oscillations in number.ii Factors influencing population change. <p>Density-independent factors to include temperature and rainfall.</p> <p>Density-dependent factors to include disease, food supply, predation and competition.</p>		<p>Design and carry out an investigation into the density of a suitable organism in relation to different environmental conditions.</p> <p>Analyse data to show density independence.</p> <p>Analyse data to illustrate predator/prey interactions, perhaps using a computer simulation.</p>

National Course Specification: course details (cont)

COURSE Biology (Higher)

ASSESSMENT

To gain the award of the course, the candidate must pass all the unit assessments as well as the external assessment. External assessment will provide the basis for grading attainment in the course award.

When the units are taken as component parts of a course, candidates will have the opportunity to achieve a level beyond that required to attain each of the unit outcomes. This attainment may, where appropriate, be recorded and used to contribute towards course estimates, and to provide evidence for appeals. Additional details are provided where appropriate, with the exemplar assessment materials. Further information on the key principles of assessment are provided in the paper, *Assessment* (HSDU, 1996) and in *Managing Assessment* (HSDU, 1998).

DETAILS OF THE INSTRUMENTS FOR EXTERNAL ASSESSMENT

The external course examination will sample across all of the unit outcomes and achievement will be graded on the basis of cut-off scores.

The assessment of knowledge and understanding, problem solving and practical abilities will be based upon the course content described for the three units:

- *Cell Biology (H)*
- *Genetics and Adaptation (H)*
- *Control and Regulation (H)*.

The content contexts of these units will be sampled equally in the course examination which will include familiar contexts as well as contexts which are less familiar and more complex than in the unit assessments. While there are no compulsory practicals for the purposes of external assessment, there will be questions set in the examination on practical work in contexts less familiar to candidates.

The examination will consist of one paper of 2 hours 30 minutes with a total of 130 marks. The paper will consist of three sections:

Section A

This section will contain 30 multiple choice questions. Of these, between 9 and 11 questions will test problem solving and/or practical abilities, the remainder will test knowledge and understanding. Section A will have an allocation of 30 marks. Candidates will be expected to answer all the questions.

Section B

This section will contain structured questions and data handling questions with an allocation of 80 marks. Between 25 and 30 marks will test problem solving and/or practical abilities, the remainder will test knowledge and understanding. Candidates will be expected to answer all the questions.

National Course Specification: course details (cont)

COURSE Biology (Higher)

Section C

This section will consist of four extended response questions to test the candidates' ability to select, organise and present relevant knowledge. Section C will have an allocation of 20 marks and will include:

- two structured extended-response questions for 10 marks. Candidates will be expected to answer one of these questions. Marking schemes for these questions will be similar to current practice for essay questions.
- two open extended-response questions for 10 marks (1 mark for relevance, 1 mark for coherence and 8 marks for knowledge and understanding). Candidates will be expected to answer one of these questions.

GRADE DESCRIPTIONS

Grade description for C

Candidates at Grade C will have demonstrated success in achieving the component units of the course. In the course assessment candidates will generally have demonstrated the ability to:

- retain knowledge and skills over an extended period of time
- integrate knowledge and understanding, problem solving and practical abilities acquired across component units
- apply knowledge and understanding, problem solving and practical abilities in contexts similar to those in the component units.

Grade description for A

In addition candidates at Grade A will generally have demonstrated the ability to:

- retain an extensive range of knowledge and skills over an extended period of time
- integrate an extensive range of knowledge and understanding, problem solving and practical abilities acquired across component units
- apply knowledge and understanding, problem solving and practical abilities in contexts less familiar and more complex than in the component units.

Testing of the course outcomes

The following gives advice on how the course outcomes will be assessed.

Knowledge and understanding

Candidates should be tested on their ability to recall learning and understand facts and principles detailed in the content statements and supplementary notes in the content tables in the course specification.

National Course Specification: course details (cont)

COURSE Biology (Higher)

Problem solving and practical abilities

Questions relating to each of the following points will be included in the course examination in order to test the candidates' ability to:

1. Select relevant information from texts, tables, charts, keys, graphs and/or diagrams.
2. Present information appropriately in a variety of forms, including written summaries, extended writing, tables and/or graphs.
3. Process information accurately using calculations where appropriate. Calculations to include percentages, averages and/or ratios. Significant figures and units should be used appropriately.
4. Plan and design experimental procedures to test given hypotheses or to illustrate particular effects. This could include identification of variables, controls and measurements or observations required.
5. Evaluate experimental procedures in situations that are unfamiliar, by commenting on the purpose or approach, the suitability and effectiveness of procedures, the control of variables, the limitations of equipment, possible sources of error and/or suggestions for improvement.
6. Draw valid conclusions and give explanations supported by evidence or justification. Conclusions should include reference to the overall pattern to readings or observations, trends in results or comment on the connection between variables and controls.
7. Make predictions and generalisations based on available evidence.

Complexity of Data

The following advice is intended as general guidelines in setting the complexity of data to be used in problem solving questions.

At Higher typically two sources of data (text, tables, charts, keys, diagrams or graphs) should be provided from which the problem has to be solved. It is however recognised that extracting data from one source could be more demanding than extracting data from two sources for example, depending upon the nature of the data.

Where there are not two separate sources of data, the provided data should normally have two to three patterns, trends, conditions, variables or sets of results from which information has to be selected and presented, or which have to be used as sources of evidence for conclusions, explanations, predictions or generalisations. The analysis of data should involve comparisons between two or more of these sets of data.

The planning designing and evaluation of experimental procedures should involve up to two of the following: one or two treatments, adequate controls, limitations of equipment, sources of error, and possible improvements as appropriate.

DETAILS OF THE INSTRUMENTS FOR INTERNAL ASSESSMENT

Outcomes 1 and 2

Outcomes 1 and 2 for each unit are assessed by a single holistic closed-book test with questions covering all the performance criteria for knowledge and understanding and problem solving. The ratio of the marks allocated to Outcomes 1 and 2 is 3:2.

National Course Specification: course details (cont)

COURSE Biology (Higher)

Outcome 3

A report of one experimental activity is required covering all the performance criteria set out in the unit specifications.

Candidates are only required to produce one report for Outcome 3 which relates to the contents and notes specified for Higher Biology. This report can then be used as evidence for Outcome 3 for all of the units of the course.

APPROACHES TO LEARNING AND TEACHING

Suggestions for appropriate learning activities are contained in the tables of course content. An investigative approach should be taken to the learning and teaching of biology. Such an approach not only draws heavily on experimental work but should provide opportunities to develop individual and group research using a variety of resources alongside the more traditional approaches of whole class teaching.

Practical work should contain a balance of illustrative experimental work and investigative practical work. Practical work can provide one way of delivering theoretical knowledge related to knowledge and understanding performance criteria. Fieldwork can also provide an opportunity for practical work using first-hand experience of an ecosystem to develop knowledge and understanding and problem solving. Practical investigations should be used to develop both problem solving and practical skills and not just to provide reports for the purposes of internal assessment. For example, investigative work provides opportunities to develop the problem solving performance criteria of planning and designing an investigation and presents opportunities to make predictions and generalisations which can then be tested in practical contexts.

Laboratory work should include the use of instrumentation and equipment that reflects current scientific use. Opportunities should be taken to capture data through computer interfacing, data loggers or videos. Such data may then be analysed by information technology (IT) or used for control technology.

Use of the additional 40 hours

This time may be used:

- to provide an introduction to the course and assessment methods
- to allow more practical work to be undertaken by the candidates
- for remediation of particular aspects of work in which candidates require to be re-assessed
- for consolidation and integration of learning
- to practice techniques in answering multiple-choice questions
- to develop extended response writing skills
- to practice applying knowledge and understanding, problem solving and practical abilities in contexts more complex than in the units
- to complete Outcome 3 reports.

National Course Specification: course details (cont)

COURSE Biology (Higher)

SPECIAL NEEDS

This course 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, 2001).

National Unit Specification: general information

UNIT Cell Biology (Higher)

NUMBER D029 12

COURSE Biology (Higher)

SUMMARY

The unit seeks to develop knowledge and understanding, problem solving and practical abilities in the context of cell structure in relation to function, photosynthesis, energy release, the synthesis and release of proteins and cellular response in defence. This is a component unit of Higher Biology.

OUTCOMES

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

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have attained one of the following:

- Standard Grade Biology with Knowledge and Understanding and Problem Solving at Credit level
- Intermediate 2 Biology.

In particular, candidates should have a clear understanding of the Standard Grade Biology topics of photosynthesis, cell structure, cell respiration and diffusion, or have achieved the unit: *Living Cells (Int 2)*.

Administrative Information

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National Unit Specification: general information (cont)

UNIT Cell Biology (Higher)

CREDIT VALUE

1 credit at Higher.

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 Biology (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 biology.

Performance criteria

- (a) Cell structure is described correctly in relation to function.
- (b) Photosynthesis is described correctly in terms of the role of light and photosynthetic pigments, photolysis and carbon fixation.
- (c) Energy release is described correctly in relation to the role and production of ATP.
- (d) The synthesis and release of proteins is described correctly in terms of the role of DNA, RNA and cellular organelles.
- (e) Cellular response in defence is described correctly in relation to animals and plants.

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 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. Problems must be set in the context of cell structure in relation to function, photosynthesis, energy release, the synthesis and release of proteins or cellular response in defence.

National Unit Specification: statement of standards (cont)

UNIT Cell Biology (Higher)

OUTCOME 3

Collect and analyse information related to 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 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

UNIT Cell Biology (Higher)

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 CONTENT AND CONTEXT FOR THIS UNIT

Outcome 1

a) Cell structure in relation to function

- i Cell variety.
The concept of variation in structure between cells of one type of tissue and between cells of different types of tissue.
The existence of unicellular organisms.
The relationship of structure to function.
- ii Absorption and secretion of materials.
Diffusion and osmosis as basic cell processes. The role of the cell wall and plasma membrane in relation to these processes.
Cell wall: reference to cellulose fibres and permeability.
Plasma membrane: reference to fluid mosaic model.
Function of plasma membrane in relation to selective ion uptake (active transport) and absorption and release of chemicals.

b) Photosynthesis

- 1 The role of light and photosynthetic pigments.
 - i Absorption, transmission and reflection of light by a leaf.
 - ii Role of chlorophyll and other photosynthetic pigments.
 - iii Separation of photosynthetic pigments by means of chromatography.
- 2 The light dependent stage and carbon fixation

The detailed structure of chloroplasts should be related to the stages of photosynthesis.

- i Photolysis
The location and significance of the light dependent stage.
The production of ATP and hydrogen (for use in carbon fixation).
- ii The location and significance of carbon fixation (Calvin cycle).
The production of glucose as a result of an enzyme-controlled sequence of reactions requiring ATP, hydrogen (from photolysis) and carbon dioxide.

National Unit Specification: support notes (cont)

UNIT Cell Biology (Higher)

c) Energy release

The role and production of ATP:

- i Importance of ATP as a means of transferring chemical energy. The role of ATP in cellular processes. Regeneration of ATP from adenosine diphosphate (ADP) and inorganic phosphate (Pi).
- ii Glycolysis.
The breakdown of glucose (6C) to pyruvic acid (3C) with a net production of ATP. Location of process within the cytoplasm.
- iii Krebs (Tricarboxylic acid, Citric acid cycle).
The production of carbon dioxide and hydrogen.
- iv The cytochrome system.
The production of ATP and water.
- v Mitochondrion structure
- vi Distinction between aerobic and anaerobic phases of respiration with reference to the level of ATP production and final metabolic products.

d) Synthesis and release of proteins

The role of DNA, RNA and cellular organelles:

- i The functional variety of proteins.
- ii DNA: structure, in particular the double helix, nucleotides and bases; pairing of named bases; genes as regions of chromosomal DNA; the process of DNA replication and its importance.
- iii RNA: single strand structure; replacement of thymine with uracil and deoxyribose with ribose; functions of mRNA and tRNA in synthesis of proteins; triplet code; codons and anti-codons.
- iv Cellular organelles: ribosomes and rough endoplasmic reticulum. Distribution within the cell and function as site of translation in protein synthesis; role of endoplasmic reticulum in transporting proteins; role of Golgi apparatus in processing molecules for secretion.

e) Cellular response in defence in animals and plants

- i The nature of viruses and their invasion of cells.
Alteration of cell instructions to produce more viruses.
- ii Cellular defense mechanisms in animals.
Phagocytosis.
Antibody production.
- iii Cellular defence mechanisms in plants.

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

National Unit Specification: support notes (cont)

UNIT Cell Biology (Higher)

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 water concentration of cell sap using plant tissue
- examine and interpret data concerning solute concentrations in aquatic organisms and their environment
- analyse data on limiting factors affecting photosynthesis
- design and carry out an investigation to show the activity of dehydrogenase enzymes in yeast
- obtain information from a variety of sources on the nature of DNA and RNA and their roles in protein synthesis
- obtain and present information on tissue transplantation including the problem of tissue rejection and the use of suppressors
- analyse data on palatability of cyanogenic and non-cyanogenic clover to herbivores.

Outcome 3

Suitable experiments in the context of this unit include:

- the chemical nature of the plasma membrane
- extraction and separation of leaf pigments by paper chromatography
- separation of photosynthetic pigments by means of thin layer chromatography
- dehydrogenase activity in yeast
- measuring the water concentration of cell sap using plant tissue.

Candidates or centres could devise other appropriate experiments in the context of cell structure in relation to function, photosynthesis, energy release, the synthesis and release of proteins or cellular response in defence in animals and plants.

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 detailed in the course specification.

National Unit Specification: support notes (cont)

UNIT Cell Biology (Higher)

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:

- 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, and explanations should be supported by evidence. Conclusion could contain a comment on trends or patterns and/or connections between variables and controls.
- 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 candidates' 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.

National Unit Specification: support notes (cont)

UNIT Cell Biology (Higher)

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 Higher Biology. This report can then be used as evidence for Outcome 3 for the other units of the course.

In relation to PC (a), the teacher/lecturer checks by observation that the candidate participates in the collection of the 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), and carrying out the experiment.

National Unit Specification: support notes (cont)

UNIT Cell Biology (Higher)

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

<p>(b) The experimental procedures are described accurately.</p>	<p>A clear statement of the aim of the experiment.</p> <p>A few brief concise sentences including as appropriate:</p> <ul style="list-style-type: none">• 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. <p>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.</p>
<p>(c) Relevant measurements and observations are recorded in an appropriate format.</p>	<p>Readings or observations (raw data) must be recorded in a clear table with correct headings, appropriate units and results/readings entered correctly.</p>
<p>(d) Recorded experimental information is analysed and presented in an appropriate format.</p>	<p>Data should be analysed and presented in tabular, graphical format or as a scatter diagram or equivalent, as appropriate:</p> <ul style="list-style-type: none">• 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.
<p>(e) Conclusions drawn are valid.</p>	<p>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:</p> <ul style="list-style-type: none">• overall pattern to readings or observations (raw data)• trends in analysed information or results• connection between variables and controls.
<p>(f) The experimental procedures are evaluated with supporting argument.</p>	<p>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:</p> <ul style="list-style-type: none">• effectiveness of procedures• control of variables• limitations of equipment• possible sources of error• possible improvements.

National Unit Specification: support notes (cont)

UNIT Cell Biology (Higher)

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 report

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. 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 may transfer evidence for Outcome 3 from one level to the one below provided the experiment is in the context of the course concerned eg. a report on measuring water concentration in cell sap could be transferred to Intermediate 2 since it is in the context of osmosis. However, a report on chromatography of photosynthetic pigments could not be transferred to Intermediate 2 since there is no equivalent context at this level.

Candidates, who are repeating a course, may carry forward evidence of an appropriate standard, generated in a previous year.

National Unit Specification: support notes (cont)

UNIT Cell Biology (Higher)

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, 2001).

National Unit Specification: general information

UNIT Genetics and Adaptation (Higher)

NUMBER D030 12

COURSE Biology (Higher)

SUMMARY

The unit seeks to develop knowledge and understanding and problem solving in the context of variation, selection and speciation, and animal and plant adaptations. This is a component unit of Higher Biology.

OUTCOMES

- 1 Demonstrate knowledge and understanding related to genetics and adaptation.
- 2 Solve problems related to genetics and adaptation.
- 3 Collect and analyse information related to Higher Biology obtained by experiment.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have attained one of the following:

- Standard Grade Biology with Knowledge and Understanding and Problem Solving at Credit level
- Intermediate 2 Biology.

Administrative Information

Superclass: RH

Publication date: June 2002

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National Unit Specification: general information (cont)

UNIT Genetics and Adaptation (Higher)

In particular, candidates should have a clear understanding of the Standard Grade Biology topics of mitosis, nature of inheritance, monohybrid crosses, fertilisation and chromosome number, sex determination, and applications of genetic engineering, transport systems in plants, gas exchange in plants, photosynthesis, kidney structure and function, and the effects of environmental factors on behaviour. Alternatively, candidates should have achieved the units: *Living Cells (Int 2)*, *Environmental Biology and Genetics (Int 2)*, and *Animal Physiology (Int 2)*.

CREDIT VALUE

1 credit at Higher.

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 Genetics and Adaptation (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 genetics and adaptation.

Performance criteria

- (a) Variation is described correctly in terms of meiosis and the dihybrid cross, linkage and crossing over, and mutation.
- (b) Selection and speciation is described correctly in terms of natural and artificial selection.
- (c) Animal and plant adaptations are described correctly with respect to maintaining a water balance, obtaining food and coping with dangers.

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 genetics and adaptation.

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. Problems must be set in the context of variation selection and speciation, or animal and plant adaptations.

National Unit Specification: statement of standards (cont)

UNIT Genetics and Adaptation (Higher)

OUTCOME 3

Collect and analyse information related to 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 in relation to the contents and notes specified for 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

UNIT Genetics and Adaptation (Higher)

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 CONTENT AND CONTEXT FOR THIS UNIT

Outcome 1

a) Variation

- 1 Meiosis and the dihybrid cross.
 - i Sexual reproduction as a means of enabling genetic variation to be maintained in the population and its importance in long-term evolutionary change.
 - ii Outline of meiosis: haploid gamete production.
Crossing over and independent assortment of chromosomes during meiosis: a means of producing new phenotypes.
 - iii The dihybrid cross: expected F₂ phenotypic ratio.
- 2 Linkage and crossing over.
 - i The existence of linked genes and its effect on the F₂ generation.
Comparison of the distance between linked genes and the frequency of recombination.
 - ii Crossing over of genes at chiasmata during meiosis resulting in recombinant gametes.
Separation of linked genes as a source of variation.
 - iii Sex linkage.
- 3 Mutation.
 - i Characteristics of mutant alleles, to include random occurrence and low frequency.
 - ii Mutagenic agents.
 - iii Changes in the number of chromosomes through non-disjunction.
 - iv Polyploidy: advantages in crop production.
 - v Change in the structure of one chromosome (duplication, translocation, deletion, inversion).
 - vi Alteration of base type or sequence (substitution, insertion, deletion, inversion).

b) Selection and speciation

- 1 Natural selection
 - i The survival of those organisms best suited to their environment.
 - ii The concept of the species.
 - iii The importance of isolating mechanisms as barriers to gene exchange leading to evolution of new species.
 - iv Adaptive radiation.
 - v The high-speed evolution of organisms such as antibiotic resistant bacteria and the melanic peppered moth.
 - vi The conservation of species through wildlife reserves, captive breeding and cell banks.
The maintenance of genetic diversity.

National Unit Specification: support notes (cont)

UNIT Genetics and Adaptation (Higher)

- 2 Artificial selection.
 - i The evolution of a wide variety of crops and domesticated animals through selective breeding and hybridisation as undertaken by humans.
 - ii The contribution of genetic engineering to the development of new varieties.
 - iii Somatic fusion in plants to produce new species.

c) Animal and plant adaptations

- 1 Maintaining a water balance.

Animals

- i Osmoregulation in freshwater fish and saltwater bony fish.
- ii Adaptations associated with salmon and eel migration.
- iii Water conservation in the desert mammal.

Plants

- i The transpiration stream.
- ii Stomatal mechanism.
- iii Adaptations in xerophytes and hydrophytes.

- 2 Obtaining food.

Animals

- i Foraging behaviour and search patterns in animals.
- ii Economics of foraging behaviour.
- iii Examples of interspecific and intraspecific competition arising from scarcity of resources.
- iv Dominance hierarchy and cooperative hunting within the social group.
- v Territorial behaviour in relation to competition for food.

Plants

- i Comparison of the sessility of plants and the mobility of animals.
- ii Competition in plants mainly for light and soil nutrients.
- iii The effect of grazing by herbivores on species diversity.
- iv Comparison of the compensation point in sun and shade plants.

- 3 Coping with dangers.

Animals

- i Avoidance behaviour and habituation.
- ii Learning as a long-term modification of response.
- iii Individual and social mechanisms for defence.

Plants

- i Structural defence mechanisms.
- ii Ability to tolerate grazing.

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

National Unit Specification: support notes (cont)

UNIT Genetics and Adaptation (Higher)

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 examine the phenotypes arising from dihybrid crosses
- obtain and interpret information relating to linkage from examination of appropriate material, for example, *Drosophila*, corn cobs
- obtain and present information relating to mutation from the examination of appropriate material, for example normal/spelt wheat, popcorn/podcorn cobs, normal/albino mice
- obtain and present information on the distribution of British buttercup species
- obtain and present information on heavy metal resistance in grasses, calcicole/calcifuge pairs in *Viola* species or the bladder champions
- analyse and interpret current data on distribution of peppered moths
- analyse information on selective breeding by means of suitable computer simulation
- obtain and present information about osmoregulation in fresh and saltwater bony fish
- obtain and present information about osmoregulation in a desert mammal
- design and carry out an investigation to compare transpiration rates.

Outcome 3

Examples of suitable experiments in the context of this unit include:

- comparison of transpiration rates
- the escape response, including habituation
- learning using a finger maze
- examining the phenotypes from a dihybrid cross in *Drosophila*
- examining the phenotypes from a dihybrid cross in tomato plants
- stomatal opening and closing in *Commelina communis L*
- planarian activity in presence and absence of food
- the response of sun and shade plants to green light
- the relationship of the number of spines on holly leaves to the height above the ground.

Candidates or centres could devise other appropriate experiments in the context of variation, selection and speciation, or animal and plant adaptations.

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 detailed in the course specification.

National Unit Specification: support notes (cont)

UNIT Genetics and Adaptation (Higher)

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:

- 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, and explanations should be supported by evidence. Conclusions could contain a comment on trends or patterns and/or connections between variables and controls.
- 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 candidates' 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.

National Unit Specification: support notes (cont)

UNIT Genetics and Adaptation (Higher)

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 Higher Biology. This report can then be used as evidence for Outcome 3 for the other Units of the course.

In relation to PC (a), the teacher/lecturer checks by observation that the candidate participates in the collection of the 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), and carrying out the experiment.

National Course Specification: support notes (cont)

UNIT Genetics and Adaptation (Higher)

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

<p>(b) The experimental procedures are described accurately.</p>	<p>A clear statement of the aim of the experiment.</p> <p>A few brief concise sentences including as appropriate:</p> <ul style="list-style-type: none"> • 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. <p>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.</p>
<p>(c) Relevant measurements and observations are recorded in an appropriate format.</p>	<p>Readings or observations (raw data) must be recorded in a clear table with correct headings, appropriate units and results/ readings entered correctly.</p>
<p>(d) Recorded experimental information is analysed and presented in an appropriate format.</p>	<p>Data should be analysed and presented in tabular, graphical format or as a scatter diagram or equivalent, as appropriate:</p> <ul style="list-style-type: none"> • 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.
<p>(e) Conclusions drawn are valid.</p>	<p>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:</p> <ul style="list-style-type: none"> • overall pattern to readings or observations (raw data) • trends in analysed information or results • connection between variables and controls.
<p>(f) The experimental procedures are evaluated with supporting argument.</p>	<p>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:</p> <ul style="list-style-type: none"> • effectiveness of procedures • control of variables • limitations of equipment • possible sources of error • possible improvements.

National Unit Specification: support notes (cont)

UNIT Genetics and Adaptation (Higher)

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 report

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. 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 may transfer evidence for Outcome 3 from one level to the one below provided the experiment is in the context of the course concerned.

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, 2001).

National Unit Specification: general information

UNIT	Control and Regulation (Higher)
NUMBER	D031 12
COURSE	Biology (Higher)

SUMMARY

The unit seeks to develop knowledge and understanding and problem solving in the context of variation, selection and speciation, and animal and plant adaptations. This is a component unit of Higher Biology.

OUTCOMES

- 1 Demonstrate biological knowledge and understanding related to control and regulation.
- 2 Solve problems related to control and regulation.
- 3 Collect and analyse information related to Higher Biology obtained by experiment.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have attained one of the following:

- Standard Grade Biology with Knowledge and Understanding and Problem Solving at Credit level
- Intermediate 2 Biology.

Administrative Information

Superclass:	RH
Publication date:	June 2002
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National Unit Specification: general information (cont)

UNIT Control and Regulation (Higher)

In particular, candidates should have a clear understanding of the Standard Grade Biology topics of the effect of environmental conditions on plants, cell division, chromosomes, genes, control by chromosomes, abiotic factors, ecosystems, feeding relationships, energy flow, population growth, controlling factors, control and management in ecosystems, water balance, kidney structure and function, the need for food, diffusion, osmosis and enzyme activity. Alternatively, candidates should have achieved the units: *Living Cells (Int 2)*, *Environmental Biology and Genetics (Int 2)* and *Animal Physiology (Int 2)*.

CREDIT VALUE

1 credit at Higher.

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 Control and Regulation (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 biological knowledge and understanding related to control and regulation.

Performance criteria

- (a) Control of growth and development is described correctly in terms of growth differences between plants and animals, genetic control, hormonal influences, and environmental influences.
- (b) Physiological homeostasis is described correctly in relation to the principle of negative feedback.
- (c) Population dynamics is described correctly in relation to regulation of plant and animal populations.

Evidence requirements

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

OUTCOME 2

Solve problems related to control and regulation.

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. Problems must be set in the context of the control of growth and development, physiological homeostasis or population dynamics.

National Unit Specification: statement of standards (cont)

UNIT Control and Regulation (Higher)

OUTCOME 3

Collect and analyse information related to 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 in relation to the contents and notes specified for 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

UNIT Control and Regulation (Higher)

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 CONTENT AND CONTEXT FOR THIS UNIT

Outcome 1

a) Control of growth and development

- 1 Growth differences between plants and animals.
 - i Position and activity of meristems in plants, absence of meristems in animals.
 - ii Formation of annual rings.
 - iii Regeneration in angiosperms and mammals.
 - iv Growth patterns in plants and animals to include an annual plant, a tree, a human and a locust.

- 2 Genetic control.
 - i An introduction to the Jacob-Monod hypothesis of gene action in bacteria.
 - ii The part played by genes in controlling metabolic pathways as shown in the case of phenylketonuria.
 - iii The control of cell differentiation by switching particular genes on or off.

- 3 Hormonal influences.
 - i Pituitary hormones.
The role of the pituitary gland in the control of growth and development involving human growth hormone (GH) and thyroid stimulating hormone (TSH).
 - ii Plant growth substances.
As exemplified by indole acetic acid (IAA) and gibberellic acid (GA).
Sites of production of IAA. Effects of IAA at cellular and organ levels; role in apical dominance, leaf abscission, fruit formation.
Effects of GA on dormancy and in dwarf varieties of plants.
Role of GA in α -amylase induction in barley grains.
Practical applications of plant growth substances as illustrated by herbicides and rooting powders.

- 4 Environmental influences.
 - i The importance of individual macro-elements.
Symptoms of deficiency of nitrogen, phosphorus, potassium and magnesium in plants.
The importance of iron and calcium in animals.
The inhibiting effect of lead on enzyme activity.
 - ii The effect of vitamin D deficiency in humans.
 - iii The effect of drugs on fetal development: thalidomide, alcohol, nicotine.
 - iv Light.
The effect of light on vegetative shoot growth and development.
The effect of light on flowering in long-day and short-day plants.
The effect of light on the timing of breeding in birds and mammals.

National Unit Specification: support notes (cont)

UNIT Control and Regulation (Higher)

b) Physiological homeostasis

The principle of negative feedback:

- i The need to maintain conditions within tolerable limits.
- ii Water content of blood and concentration of cell chemicals.
- iii Glucose and energy needs of tissue.
- iv Temperature: the importance of temperature to enzyme – controlled metabolic processes in the body.
- v Endotherms and ectotherms.

c) Population dynamics

Regulation of plant and animal populations:

- i Population fluctuations: the relative stability of populations, despite short-term oscillations in number.
- ii Factors influencing population change.
Density-independent factors to include temperature and rainfall.
Density-dependent factors to include disease, food supply, predation and competition.
- iii Monitoring populations.
The need to monitor wild populations.
- iv Succession and climax in plant communities.

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:

- obtain and present information on growth patterns in a variety of organisms including an annual plant, a tree, a human and a locust
- obtain and present information on the nature and occurrence of phenylketonuria
- design and carry out an investigation to compare the effects of different concentrations of a plant growth substance on plant growth
- analyse data on the effect of alcohol or nicotine on birthweight
- analyse data on kidney function
- obtain and present information on blood sugar concentrations in diabetic and non-diabetic humans
- obtain and present information on fluctuations in plant and animal populations
- design and carry out an investigation into the density of a suitable organism in relation to different environmental conditions
- analyse data to show density independence
- analyse data to illustrate predator/prey interactions, perhaps using a computer simulation.

National Unit Specification: support notes (cont)

UNIT Control and Regulation (Higher)

Outcome 3

Examples of suitable experiments in the context of this unit include:

Control and Regulation

- the effects of indole acetic acid (IAA) on root growth in mustard seedlings
- the role of gibberellic acid (GA) in α -amylase induction in barley grains
- induction of the lac operon in *E. coli*
- the effects of different minerals on plant growth
- inhibition of catechol oxidase by lead
- human body response to sudden heat loss
- the density of woodlice in relation to different environmental conditions.

Candidates or centres could devise other appropriate experiments in the context of the control of growth and development, physiological homeostasis and population dynamics.

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 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:

- 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, and explanations should be reported by evidence. Conclusions could contain a comment on trends or patterns and/or connections between variables and controls.

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- 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 candidates' 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 Higher Biology. This report can then be used as evidence for Outcome 3 for the other units of the course.

In relation to PC (a), the teacher/lecturer checks by observation that the candidate participates in the collection of the 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), and carrying out the experiment.

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:

<p>(b) The experimental procedures are described accurately.</p>	<p>A clear statement of the aim of the experiment.</p> <p>A few brief concise sentences including as appropriate:</p> <ul style="list-style-type: none"> • 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. <p>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.</p>
<p>(c) Relevant measurements and observations are recorded in an appropriate format.</p>	<p>Readings or observations (raw data) must be recorded in a clear table with correct headings, appropriate units and results/readings entered correctly.</p>
<p>(d) Recorded experimental information is analysed and presented in an appropriate format.</p>	<p>Data should be analysed and presented in tabular, graphical format or as a scatter diagram or equivalent, as appropriate:</p> <ul style="list-style-type: none"> • 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.
<p>(e) Conclusions drawn are valid.</p>	<p>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:</p> <ul style="list-style-type: none"> • overall pattern to readings or observations (raw data) • trends in analysed information or results • connection between variables and controls.
<p>(f) The experimental procedures are evaluated with supporting argument.</p>	<p>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:</p> <ul style="list-style-type: none"> • effectiveness of procedures • control of variables • limitations of equipment • possible sources of error • possible improvements.

National Unit Specification: support notes (cont)

UNIT Control and Regulation (Higher)

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 report

Candidates may complete their work 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. 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 may transfer evidence for Outcome 3 from one level to the one below provided the experiment is in the context of the course concerned.

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, 2001).