

GCE

Edexcel Advanced Subsidiary GCE in Biology (Salters-Nuffield) (8048)

First examination 2006

Edexcel Advanced GCE in Biology (Salters-Nuffield) (9048)

First examination 2007

January 2005

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Specification

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Contents

Introduction	1
Key features	1
Outline of specification	2
Rationale for the specification	2
Specification overview	3
Aims of the specification	3
Prior learning and progression	3
Forbidden combinations and related subjects	4
Physical science background	4
Scheme of assessment	5
Summary of unit numbers, subject codes and availability	5
Summary of scheme of assessment	5
Summary of the specification content	6
Subject criteria	7
Assessment objectives	7
Summary of weighting of assessment objectives	8
Synoptic assessment	8
Relationship of assessment objectives to units	9
Scheme and specification of unit tests	9
Scheme of assessment	10
Quality of written communication	11
Experimental and investigative skills	12
Mathematical skills	13
Key skills	14
Spiritual, moral, ethical, social and cultural aspects	14
Health education	14
Environmental education	15
The European dimension	15
Unit and resit rules	15

Awarding and reporting	15
Language of assessment	15
Students with particular requirements	16
Specification content	17
Presentation of the specification by topic	18
Unit 1: Lifestyle, Transport, Genes and Health	18
Unit 2: Development, Plants and the Environment	21
Unit 3: Report and Practical Review	24
Unit 4: Environment and Survival	30
Unit 5: Energy, Exercise and Coordination: Coursework Investigation	33
Practical assessment in Unit 5	36
Presentation of the specification by themes – AS	44
Presentation of the specification by themes – A2	50
Textbooks and other resources	56
Support and training	58
Support from the project team	58
Support from Edexcel	58
Examiner report and comments	59
Training	59
Regional offices and enquiries	59
Other useful contacts	59
Grade descriptions for advanced level	60
Appendices	62
Appendix 1: Glossary of terms used in the specification and in the written tests	62
Appendix 2: Key skills mapping – summary table	64
Appendix 3: Key Skills development suggestions	66
Appendix 4: Sample student authentication sheets	82

Introduction

Key features

- ◆ New and innovative approach to biology.
- ◆ Content taught through eight contemporary topics to motivate students.
- ◆ Exclusive dedicated website, multimedia resources and course texts.
- ◆ Online, specifically devised activities to support topics.
- ◆ Online activities to develop and support related science, maths and ICT skills.
- ◆ Downloadable activity sheets with teacher and technician notes.
- ◆ Novel approach to AS practical assessment marked by Edexcel.
- ◆ Electronic submission and moderation of A2 coursework.
- ◆ Assessed study in A2 of a piece of published scientific writing.
- ◆ INSET programme to support teaching and learning.
- ◆ Support from Edexcel and the Salters-Nuffield Project Team.

Outline of specification

This Advanced GCE specification is divided into six units and incorporates requirements of the subject criteria for Biology, with the exception of some aspects of assessment objective AO3.

The Advanced Subsidiary (AS) specification comprises Units 1, 2 and 3. The AS practical assessment component in Unit 3 has two parts; Paper 01 a record of a visit to a site of biological interest or a report of non-practical research into a biological topic and Paper 02 a review of practical work. Both these components will be marked by Edexcel.

The Advanced GCE specification comprises Units 1 to 6 and includes synoptic assessment. In the A2 part of the Advanced GCE, practical skills are assessed in Unit 5; students will submit a written report of an experimental investigation that they have devised and carried out. This will be marked by the teacher and moderated by Edexcel. A proportion of the synoptic assessment in Unit 6 will be based on questions involving a published piece of scientific writing that students will have studied during the course.

Rationale for the specification

The Edexcel AS and Advanced GCE in Biology (Salters-Nuffield) specifications develop knowledge, understanding and skills related to biology. It has been designed to motivate students by helping them to realise how an understanding of many of today's contemporary issues requires the knowledge and understanding of underpinning biological principles.

Students cover the AS and the Advanced GCE subject material in compulsory units. Practical skills are seen as an integral accompaniment to theory work. Practical skills will be assessed in AS and in A2 of the Advanced GCE.

Specification overview

Aims of the specification

The aims of the Edexcel AS and Advanced GCE in Biology (Salters-Nuffield) specifications are to:

- develop essential knowledge and understanding of biological facts, concepts and principles together with an appreciation of their significance, and the skills needed for their use in new and changing situations
- promote an appreciation of the importance of experimental and investigatory work in the study of biology and develop an understanding of the links between theory and experiment
- develop an understanding of various scientific methods used by biologists
- show knowledge and understanding of the facts, principles and concepts from different areas of biology and to be able to make connections between them
- sustain and develop an interest in the study of living organisms and a respect for them
- enable students to evaluate and use arguments about the place of biology in society
- promote an appreciation of the development and significance of biology in personal, social, environmental, economic and technological contexts and an awareness of advances in technology, including IT, relevant to biology
- be complete in themselves and perform a useful educational function for students not intending to study biology at a higher level
- be a suitable preparation for biological studies in higher and other educational establishments and for professional courses which require students to have a knowledge of biology when admitted
- provide opportunities for an appreciation of the social, moral and ethical complexities of many current biological issues.

In following the Edexcel AS and Advanced GCE Biology (Salters-Nuffield) specifications, students will be made aware that biology is not to be studied in isolation, but relates, in a wider sense, to the needs of people and other organisms. The relevance of biology to everyday life should therefore be borne in mind when studying the whole of the specification. Relevant and important aspects of modern life should be stressed, including those of a personal, social, environmental, economic and technological nature.

Prior learning and progression

The AS GCE and Advanced GCE in Biology is a Level 3 qualification in the National Qualifications Framework and builds on the knowledge, understanding and skills in the National Curriculum Key Stage 4 programme of study for Double Science or equivalent. It is expected that most students will have achieved at least a grade CC in GCSE Science (Double Award) or GCSE Applied Science (Double Award), grade C in GCSE Science: Biology, two grade Cs in GCSE Science and GCSE Additional Science, an Intermediate GNVQ Science or a BTEC First in Science.

Successful completion of the Edexcel AS and Advanced GCE in Biology (Salters-Nuffield) offers students several routes for progression. These routes include:

- progression on to a range of higher education courses, including degrees (eg medicine, life sciences) and Higher Nationals (eg applied sciences, sports science)
- direct entry into employment, especially into the science and related sectors
- progression on to Level 4 vocational qualifications, especially into the sciences or related areas (eg NVQs in Laboratory and Associated Technical Activities).

The qualification supports lifelong learning by offering staged and end of course modes of assessment. Students can study the AS or Advanced GCE over a period of time banking units as they progress. The shelf-life of the qualification will be determined by the availability of the specification.

Forbidden combinations and related subjects

Students entering for this specification should be aware that there are no forbidden combinations.

Every specification is assigned a national classification code indicating the subject area to which it belongs. The classification code for this specification is 1010.

Centres should be aware that students who enter for more than one GCE qualification with the same classification code will have only one grade (the highest) counted for the purpose of the School and College Performance Tables.

The Edexcel AS and Advanced GCE in Biology (Salters-Nuffield) are distinctive and have no significant overlap with GCEs in Chemistry and Physics.

Additionally, there is no significant overlap with other Level 3 qualifications, for example:

- VCEs in Science or Health and Social Care
- BTEC Nationals in Applied Science, Sport and Exercise Sciences, Dental Technology and Pharmacy Services
- NVQ Level 3 in Laboratory and Associated Technical Activities and NVQ Level 3 in Laboratory Technicians in Education.

Physical science background

To answer the questions set in the examinations, students should have some understanding of the following: elements, electrons, ions, atoms, molecules, hydrogen bonds, the use of formulae in chemical equations, hydrolysis, condensation, electron and proton transfer, acidity, pH scale, buffering, energy changes, the electromagnetic spectrum, latent heat, diffusion, solubility, pressure and partial pressure.

It is expected that students would have knowledge of some of these topics at the start of the course, whilst knowledge of other topics can be acquired during the course at appropriate points through the use of the accompanying course materials.

Unless specifically stated, details of chemical structure or of biochemical reactions are not required.

Scheme of assessment

Summary of unit numbers, subject codes and availability

Unit and code	January 2006	June 2006	January 2007	June 2007
Unit 1 (6131)	✓	✓	✓	✓
Unit 2 (6132)	-	✓	-	✓
Unit 3 (6133)	-	✓	-	✓
Unit 4 (6134)	-	-	✓	✓
Unit 5 (6135)	-	-	-	✓
Unit 6 (6136)	-	-	-	✓

Note: This table gives the availability for the first two years, for non-pilot centres. The rest of the availability will be the same as for 2007.

Summary of scheme of assessment

Unit number and title	Level	Duration	Weighting	
			AS	A2
Unit 1: Lifestyle, Transport, Genes and Health	AS	1 hour 15 minutes	30%	15%
Unit 2: Development, Plants and the Environment	AS	1 hour 30 minutes	40%	20%
Unit 3: Report and Practical Review Paper 01 Visit or Issue Report And Paper 02 Practical Work Review	AS	Coursework (marked by Edexcel) 1 hour	30%	15%
Unit 4: Environment and Survival	A2	1 hour 15 minutes	-	15%
Unit 5: Energy, Exercise and Coordination: Coursework Investigation Paper 01 Test And Paper 02 Coursework Investigation	A2	1 hour Coursework (marked by the teacher, moderated by Edexcel)	-	20%
Unit 6: Synoptic Paper	A2	2 hours	-	15%

Summary of the specification content

Edexcel AS/Advanced GCE in Biology (Salters-Nuffield)	
Unit 1	Lifestyle, Transport, Genes and Health Topic 1 Lifestyle, health and risk Topic 2 Genes and health
Unit 2	Development, Plants and the Environment Topic 3 The voice of the genome Topic 4 Plants and climate change
Unit 3	Report and Practical Review This unit has two components, both marked by Edexcel, based on the practical work carried out in Units 1 and 2.
Paper 01	Students will complete a written Visit or Issue Report, which must be either a record of a visit to a site of biological interest or a report of non-practical research into a biological topic.
Paper 02	Students will sit a written paper (Practical Work Review), to which they will attach their reports of the two practicals they have chosen to review.
Unit 4	Environment and Survival Topic 5 On the wild side Topic 6 Infection, immunity and forensics
Unit 5	Energy, Exercise and Coordination: Coursework Investigation This unit will have two components: Theory Paper 01 and Coursework Investigation Paper 02.
Paper 01	This will be a test on Topics 7 and 8 Topic 7 Run for your life Topic 8 Grey matter
Paper 02	Students will complete a Coursework Investigation. This is a written report of an experimental investigation, which they have devised and carried out and which includes some synoptic assessment. This piece of coursework will be marked by the teacher and moderated by Edexcel.
Unit 6	Synoptic Paper The synoptic paper will give students the opportunity to make connections between different units of the specification. Students will also be tested on a piece of scientific writing that they have studied during the course.

Subject criteria

This specification incorporates the subject criteria for Biology, as approved by QCA.

The knowledge, understanding and skills set out in the subject criteria comprise 50 per cent of the Edexcel AS in Biology (Salters-Nuffield) specification. For the AS and A2 combined, the knowledge, understanding and skills set out in the subject criteria comprise 50 per cent of the Edexcel Advanced GCE in Biology (Salters-Nuffield). The remainder of both the AS and the Advanced GCE specifications allows for further study and amplification, which makes the Edexcel GCE in Biology (Salters-Nuffield) a unique course of study.

Assessment objectives

The examination will test the following assessment objectives in the context of the content and skills prescribed. Assessment objectives AO1, AO2 and AO3 are the same for AS and Advanced GCE. Assessment objective AO4 is only assessed in the Advanced GCE.

AO1 Knowledge with understanding

Students should be able to:

- recognise, recall and show understanding of specific biological facts, terminology, principles, relationships, concepts and practical techniques
- draw on existing knowledge to show understanding of the ethical, social, economic, environmental and technological implications and applications of biology
- select, organise and present relevant information clearly and logically using appropriate vocabulary.

AO2 Application of knowledge and understanding, analysis, synthesis and evaluation

Students should be able to:

- describe, explain and interpret phenomena and effects in terms of biological principles and concepts, presenting arguments and ideas clearly and logically, and using specialist vocabulary where appropriate
- interpret and translate, from one form into another, data presented as continuous prose, or in tables, diagrams, drawings and graphs
- apply biological principles and concepts in solving problems in unfamiliar situations, including those which relate to the ethical, social, economic and technological implications and applications of biology
- assess the validity of biological information, experiments, inferences and statements.

A03 Experiment and investigation

Students should be able to:

- devise and plan experimental activities, selecting appropriate techniques
- demonstrate safe and skilful practical techniques
- make observations and measurements with appropriate precision and record these methodically
- interpret, explain, evaluate and communicate the results of their experimental and investigative activities, using biological knowledge and appropriate specialist vocabulary.

A04 Synthesis of knowledge, understanding and skills

Students should be able to:

- bring together principles and concepts from different areas of biology and apply them in a particular context, expressing ideas clearly and logically and using appropriate specialist vocabulary
- use biological skills in contexts which bring together different areas of biology.

Summary of weighting of assessment objectives

% Weighting of assessment objectives				
	A01	A02	A03	A04
AS	46	34	20	–
A2	25	25	10	40
Advanced GCE	35.5	29.5	15	20

Synoptic assessment

This will be assessed in **Unit 5: Paper 02 Coursework Investigation** and **Unit 6: Synoptic Paper**. Students will be expected to bring together principles and concepts from at least two units and apply them in a particular context, expressing ideas clearly and logically and using appropriate specialist vocabulary.

They will also be expected to apply biological skills in contexts, which bring together different areas of biology.

Relationship of assessment objectives to units

The percentage weighting of each of the assessment objectives in the AS and the Advanced GCE examinations will be approximately as shown in the table below.

Please note that all values are given as percentages.

The papers for unit tests 1, 2 and 3 will be set at a standard appropriate for AS students after one year of study post GCSE. The scheme and specification of the examination are summarised in the table below.

Scheme and specification of unit tests

Advanced Subsidiary GCE	AS (%)	A01 (%)	A02 (%)	A03 (%)	A04 (%)
Unit 1	30	17	13	–	–
Unit 2	40	23	17	–	–
Unit 3					
Paper 01 Visit or Issue Report	15	3	2	10	–
And					
Paper 02 Practical Work Review	15	3	2	10	–
AS Total	100%	46%	34%	20%	–

Advanced GCE	GCE (%)	A01 (%)	A02 (%)	A03 (%)	A04 (%)
Unit 1	15	8.5	6.5	–	–
Unit 2	20	11.5	8.5	–	–
Unit 3					
Paper 01 Visit or Issue Report	7.5	1.5	1	5	–
And					
Paper 02 Practical Work Review	7.5	1.5	1	5	–
Unit 4	15	7.5	7.5	–	–
Unit 5					
Paper 01 Theory Paper	10	5	5	–	–
And					
Paper 02 Coursework Investigation	10	–	–	5	5
Unit 6	15	–	–	–	15
Total Advanced GCE	100%	35.5%	29.5%	15%	20%

A minimum of 15 per cent of the marks will be allocated to personal, environmental, economic, ethical, social and technological applications. This applies to the examination as a whole and not necessarily to each unit test.

Scheme of assessment

6131 Unit 1: Lifestyle, Transport, Genes and Health

Written test **1 hour 15 minutes** **60 marks** **AS**

This test will consist of about seven compulsory structured questions each allocated from four to 12 marks, presented in a question-answer booklet. The questions will be designed to test assessment objectives AO1 and AO2.

6132 Unit 2: Development, Plants and the Environment

Written test **1 hour 30 minutes** **70 marks** **AS**

This test will consist of about eight compulsory structured questions each allocated from four to 12 marks, presented in a question-answer booklet. The questions will be designed to test assessment objectives AO1 and AO2. At least one question will require students to write in continuous prose.

6133 Unit 3: Report and Practical Review **40 marks** **AS**

There are two assessment components for this unit, Paper 01 and Paper 02 which will be designed to mainly test assessment objective AO3, with some assessment of AO1 and AO2

Paper 01 Visit or Issue Report **20 marks** **AS**

Students will present a written report of around 1500 words (maximum 2000) which will be marked by Edexcel. The report may be a record of a visit to a site of biological interest, or a report of non-practical research into a biological topic. The report must be word processed. Further details can be found on page 24 onwards.

Paper 02 Practical Work Review **20 marks** **AS**

Students will sit a written paper (Practical Work Review) to which they will attach their write-up of the two practicals they have chosen to review. The Practical Work Review will consist of three questions each worth six or seven marks. Question 1 will test their knowledge of practical techniques they will have carried out during the core practicals in Units 1 and 2. Questions 2 and 3 will test their knowledge and understanding of the experimental and investigative skills of safety and use of apparatus, producing reliable and valid results, significance of results/data, presenting data and using results to draw conclusions, using two practical accounts submitted as evidence. Students will be required to draw on their experiences of carrying out practical work in choosing those on which to base their review and in answering the questions. In general the two practical accounts submitted as evidence will not be marked by Edexcel, but on occasion a few marks in a particular question might be allocated to presentation or analysis of data. Further details can be found on page 28 onwards.

6134 Unit 4: Environment and Survival

Written test **1 hour 15 minutes** **60 marks** **A2**

This test will consist of about seven compulsory structured questions each allocated from four to 12 marks, presented in a question-answer booklet. The questions will be designed to test assessment objectives AO1 and AO2. At least one question will require students to write in continuous prose.

6135 Unit 5: Energy, Exercise and Coordination: Coursework Investigation **80 marks** **A2**

Experimental and investigative skills

The experimental and investigative skills given below are contained in assessment objective AO3 and are given here in more detail for clarification. Students will be assessed on the following abilities.

Planning

- a identify and define a problem using available information and knowledge of biology
- b choose effective and safe procedures, selecting appropriate apparatus and materials and deciding the measurements and observations likely to generate useful and reliable results
- c consider ethical implications in the choice and treatment of organisms and the environmental and safety aspects of the proposed procedures.

Implementing

- a use apparatus and materials in an appropriate and safe way
- b carry out experimental work in a methodical and organised way with due regard for safety and for the well-being of living organisms and the environment
- c make and record detailed observations in a suitable way, and make measurements to an appropriate degree of precision using IT where appropriate.

Analysing evidence and drawing conclusions

- a communicate biological information and ideas in appropriate ways, including tabulation, line graphs, histograms, continuous prose, annotated drawings and diagrams
- b recognise and comment on trends and patterns in data
- c **apply a simple statistical test and, where appropriate, assign confidence levels to experimental results**
- d draw valid conclusions by applying biological knowledge and understanding.

Material given in bold type is for Advanced GCE only.

Evaluating evidence and procedures

- a assess the reliability and precision of experimental data and the conclusions drawn from them
- b evaluate the techniques used in the experimental activity, recognising the limitations of these.

It is expected that the experimental skills specified above will be carried out as part of the experimental activities, including investigations, illustrative practical work and other aspects of experimental biology and fieldwork. They will be assessed mainly in the assessment of practical work.

Mathematical skills

Students need to have been taught and to have acquired competence in the areas of mathematics set out below in order to develop the knowledge, understanding and skills in the subject content.

Arithmetic and computation

Students should be able to:

- a recognise and use expressions in decimal and standard form
- b use ratios, fractions and percentages
- c make estimates of the results of calculations (without using a calculator)
- d use calculators to find and use x^n , $1/x$ and \sqrt{x} . Calculators should conform to General Regulations.

Handling data

Students should be able to:

- a use an appropriate number of significant figures
- b find arithmetic means
- c construct and interpret frequency tables and diagrams, bar charts and histograms
- d **have sufficient understanding of probability to explain how genetic ratios arise**
- e **explain the principles of sampling as applied to biological data**
- f **explain the importance of chance when interpreting data**
- g explain the terms mean, median and mode
- h use a scatter diagram to identify a correlation between two variables
- i **use a simple statistical test.**

Material given in bold type is for Advanced GCE only.

Algebra

Students should be able to:

- a change the subject of an equation
- b substitute numerical values into algebraic equations using appropriate units for physical quantities.

Graphs

Students should be able to:

- a translate information between graphical, numerical and algebraic forms
- b plot two variables from experimental or other data
- c calculate rate of change from a graph showing a linear relationship.

Key skills

The specification has been signposted to identify opportunities for developing and assessing the following key skills:

- communication
- information technology
- application of number
- working with others
- improving own learning and performance
- problem solving.

Further details are given in *Appendices 2 and 3*.

Spiritual, moral, ethical, social and cultural aspects

The Edexcel AS and Advanced GCE in Biology (Salters-Nuffield) specifications offers opportunities for students to explore spiritual, moral, ethical, social and cultural dimensions as well as to gain scientific knowledge and understanding of biological topics. Students will acquire an appreciation of the powerful influence of humans and their potential for changing living systems and the environment from a global perspective down to modifications at the molecular level, for instance through genetic engineering. Their studies in biology will lead them to consider moral and ethical issues in the context of actual situations. This will help them appreciate the many decisions which increasingly need to be taken both at personal and at wider national and international levels, thus including social and cultural aspects of biology.

Some specific sections where these issues may be explored and appreciated are outlined below.

Unit 1: the moral and ethical issues involved in gene therapy; the social, moral, ethical and cultural issues involved in genetic screening

Unit 2: the spiritual, moral and ethical aspects of stem cell research; the social, moral and ethical aspects of the Human Genome Project

Unit 4: the social and cultural issues involved in reconciling conflicts between wildlife and humans

Unit 5: the moral and ethical issues concerning the use of performance enhancing drugs by athletes; the moral and ethical issues related to the use of animals in medical research.

Health education

The Edexcel AS and Advanced GCE in Biology (Salters-Nuffield) specifications contain many topics relating to the structure and functioning of human systems. Health issues are given in a context which enables students to achieve a knowledge of the underpinning biological concepts as well as a fuller understanding of health issues. Some specific sections where health education can be stressed are listed below.

Unit 1: lifestyle changes to reduce the risk of coronary heart disease; the use of genetic screening

Unit 2: the genetic, environmental and lifestyle causes of cancer

Unit 4: the role of the immune system

Unit 5: the possible disadvantages of exercising too much

Environmental education

In these specifications there are topics relating to organisms in their environment and to the structure of ecosystems. Application of knowledge gained from studying these topics enables students to achieve a fuller understanding of related environmental issues at a local level through to a global perspective. Some specific sections where environmental education can be stressed are listed below.

Unit 2: possible consequences of global climate change resulting from human actions

Unit 4: conservation of genetic diversity; adaptations of species to their habitats

The European dimension

There will be opportunities to integrate the European dimension with the subject content. Some specific sections where the European dimension can be stressed are listed below.

Unit 1: the use of genetic screening

Unit 2: the Human Genome Project; global warming; climate change

Unit 4: the study of UK and international initiatives to manage conservation and development sustainably

Unit and resit rules

There is no restriction on the number of times a unit may be attempted prior to claiming certification of the qualification. The best available result for each unit will count towards the final grade.

Results of units will be held in Edexcel's unit bank for as many years as this specification remains available. Once the AS or Advanced Level qualification has been certificated, all unit results are deemed to be used up. These results cannot be used again towards a further award of the same qualification at the same level.

This specification is not available to private students.

Awarding and reporting

The grading, awarding and certification of this specification will comply with the requirements of the GCE Code of Practice for courses starting in September 2002, which is published by the Qualifications and Curriculum Authority. Qualifications will be graded and certificated on a five-point scale from A–E. Individual results will be reported.

Language of assessment

Assessment of this specification will be available in English only. Assessment materials will be published in English and all written and spoken work submitted for examination and moderation must be produced in English.

Dictionaries

Students may use bilingual dictionaries between their mother tongue and English in the examination. The dictionary must be a basic translation dictionary that does not contain additional information, which could give a student an unfair advantage. Dictionaries of scientific terms and textbooks may not be used in any circumstances in the examination.

Terminology and units

The terminology used in unit tests will be the same as that used in the specifications. SI units will be used in questions and should be used in students' answers. Reference should be made to the publication by the Institute of Biology: *Biological Nomenclature – Standard terms and expressions used in the teaching of biology* (Third Edition, 2000). These recommendations have been followed closely throughout the specification and will also be used in unit tests.

Examination questions are very carefully worded in order that they elicit the response intended by the examiners. It is therefore important that students are able to identify and respond appropriately to the key words in questions, which will guide them in selecting the answer required.

For further information see *Appendix 1*.

Students with particular requirements

Regulations and guidance relating to students with particular requirements are published annually by the Joint Council for General Qualifications and are circulated to examinations officers. Further copies of this guidance documentation may be obtained by calling Edexcel's Customer Services on 0870 240 9800 or by writing to the address below.

In accordance with the published guidelines, Edexcel is happy to assess whether special consideration or concession can be made for students with particular requirements. Requests should be addressed to:

Special Requirements
Edexcel
One90 High Holborn
London
WC1V 7BH

Specification content

This specification is designed as a series of context-based topics. Each topic focuses on a contemporary issue or theme relevant to today's students. Throughout the course, an understanding of the principles of biology should be developed and topics should be illustrated by reference to relevant applications of biology, particularly those of a personal, social, environmental, economic and technological nature. As part of the teaching, attention can be drawn to spiritual, moral, ethical, social and cultural issues, and to opportunities to integrate aspects of health and environmental education as identified on pages 14 and 15. For instance the role of diet, taking exercise and not smoking in reducing the risk of coronary heart disease is part of Topic 1 while Topic 5 gives the opportunity to discuss how conflicts between wildlife and humans can be resolved.

Great importance is attached to practical work, in the field and laboratory. The core practicals identified in the specification should be completed wherever possible. It is envisaged that the teaching will include both demonstrations and individual experiments. The reasons for using demonstrations rather than individual experiments will vary, but may include limitations of time, availability of resources and seasonal or safety considerations. Studies of structure (eg by demonstration specimens or microscopic preparations) should be undertaken wherever they clarify the functions being studied. Where appropriate, students should study living organisms and have appropriate knowledge of their behaviour and ecology.

There are two topics in each of Units 1, 2, 4 and 5. The specification content of each unit is set out, after a brief description of each topic, in a series of numbered learning outcomes. Some of these points involve practical work, and experience and knowledge of this can be tested in either the relevant unit written test or in Unit 6. Paper 02 of Unit 3 will be based on testing knowledge of the practical work and techniques from Units 1 and 2.

The content-based units, Units 1, 2, 4 and 5, should be taught in sequence starting with Unit 1, Topic 1 which is designed as a transition from GCSEs (level 2 qualifications). Knowledge of previous units will be assumed in later units. Learning outcomes, which have clear links with earlier outcomes, are identified in the introduction to each topic.

While the content of each of the topics is mostly self-contained, in the teaching of the specification, opportunities should be taken to enable students to integrate different aspects of the subject. To facilitate this approach, this specification is also presented thematically on pages 50 to 54 to enable teachers to identify which learning outcomes are linked by a common theme. Some of the themes, (eg genetics and ecology and conservation), continue from AS to A2. This is shown in the mapping of themes on page 55.

There is progression from AS through to Advanced GCE, both in the difficulty level of topics and in the skills and understanding which are acquired.

The numbering of the learning outcomes within each unit shows the unit number, topic number and the learning outcome number in sequence, eg Unit 2, Topic 4, learning outcome 6 – 'Explain the role of adhesion, cohesion and the transpiration stream in the movement of water through the stem' is numbered 2.4.6 (see page 22).

Core practicals are indicated by underlining, eg learning outcome 1.1.17 on page 19.

Presentation of the specification by topic

Unit 1: Lifestyle, Transport, Genes and Health

There are two topics in this unit: Topic 1 – Lifestyle, health and risk and Topic 2 – Genes and health.

Topic 1: Lifestyle, health and risk

This topic builds on the knowledge and understanding which students bring to the course on the functioning of the circulatory system and the importance of diet in maintaining the body. The role of diet and other lifestyle factors in maintaining good health is considered with particular reference to the heart and circulation and to cardiovascular disease (CVD). The structures and functions of some carbohydrates and lipids are also detailed within this context. The concept of risks to health is covered along with ways in which CVD may be diagnosed.

Learning outcomes

Students should be able to:

- 1.1.1 Explain why many animals have a heart and circulation (mass transport to overcome limitations of diffusion)
- 1.1.2 Explain how the structures of blood capillaries, arteries and veins relate to their functions
- 1.1.3 Relate the structure and operation of the mammalian heart to its function (the cardiac cycle including diastole, atrial systole and ventricular systole)
- 1.1.4 Explain the course of events that leads to atherosclerosis (endothelial damage, inflammatory response, plaque formation, raised blood pressure)
- 1.1.5 Describe the blood clotting process (thromboplastin release, conversion of prothrombin to thrombin and fibrinogen to fibrin) and its role in CVD
- 1.1.6 Describe the symptoms of CVD, ie coronary heart disease (CHD) and stroke, and the factors which increase the risk of CVD (genetic, diet, age, gender, high blood pressure, smoking and inactivity)
- 1.1.7 Describe what is meant by blood pressure and explain the role of high blood pressure in CVD
- 1.1.8 Describe the normal electrical activity of the heart, including the roles of the sino-atrial node (SAN), the atrio-ventricular node (AVN) and the bundle of His, and how the use of electrocardiograms (ECGs) can aid the diagnosis of CVD and other heart conditions
- 1.1.9 Analyse quantitative data on illness and mortality rates to determine health risks and recognise that it is important to distinguish between correlation and causation
- 1.1.10 Explain why people's perceptions of risks are often different from the actual risks
- 1.1.11 Analyse data on energy budgets and diet so as to be able to discuss the consequences of energy imbalance
- 1.1.12 Distinguish between monosaccharides, disaccharides and polysaccharides (glycogen and starch – amylose and amylopectin) in terms of their structure and their role in providing and storing energy (β -glucose and cellulose are not required at this stage). Students should recognise the structural formulae for α -glucose and maltose and the monomers which make up sucrose and lactose

- 1.1.13 Describe how monosaccharides join to form polysaccharides through condensation reactions forming glycosidic bonds, and how these can be split through hydrolysis reactions
- 1.1.14 Recognise that glycerol with three fatty acids attached is a lipid and specifically a triglyceride, describe the formation of ester bonds in condensation reactions and recognise differences between saturated and unsaturated lipids
- 1.1.15 Calculate body mass indices (BMIs) using the formula $BMI = \text{body mass (kg)}/\text{height}^2 \text{ (m)}$ and explain their significance
- 1.1.16 Discuss the possible significance for health of blood cholesterol levels and levels of high-density lipoproteins and low-density lipoproteins (HDLs and LDLs)
- 1.1.17 Describe how the effect of caffeine on heart rate in *Daphnia* can be investigated practically
- 1.1.18 Discuss how individuals, by changing their diet, taking exercise and not smoking, can reduce their risk of coronary heart disease.

Topic 2: Genes and health

This topic considers the following biological principles: the properties and transport of materials, across cell membranes and gas exchange surfaces, DNA structure and replication, protein synthesis and monohybrid inheritance through the context of the genetic disease cystic fibrosis (CF). The potential that gene therapy offers as treatment for CF is examined. The topic also allows for discussion of the social and ethical issues surrounding the diagnosis and treatment of genetic conditions.

Learning outcomes

Students should be able to:

- 1.2.1 Describe the properties of gas exchange surfaces (large surface to volume ratio, thickness of surface, difference in concentration) and explain how the structure of the lung provides a large surface area to volume ratio
- 1.2.2 Describe the structure of the unit membrane (fluid mosaic model) and how its structure depends on the properties of the phospholipids
- 1.2.3 Describe how the effect of temperature on membrane structure can be investigated practically
- 1.2.4 Explain what is meant by osmosis in terms of the diffusion of free water molecules through a partially permeable membrane (consideration of water potential is not required)
- 1.2.5 Explain what is meant by passive transport (diffusion, facilitated diffusion), active transport (including the role of ATP), endocytosis and exocytosis and describe the involvement of carrier and channel proteins in membrane transport
- 1.2.6 Describe the basic structure of mononucleotides as a phosphate group, deoxyribose or ribose and a base eg thymine, uracil, cytosine, adenine and guanine. Describe the structures of DNA and RNA as polynucleotides composed of mononucleotides linked in condensation reactions. Describe complementary base pairing and the hydrogen bonding involved in the formation of the DNA double helix
- 1.2.7 Explain the process of protein synthesis (transcription, translation, transfer RNA, messenger RNA, ribosomes, the role of start and stop codons) explain the roles of the template (antisense) DNA strand in transcription, codons on messenger RNA and anticodons on transfer RNAs

- 1.2.8 Explain the nature of the genetic code (triplet code, non-overlapping and degenerate) and describe a gene as being a sequence of bases on a DNA molecule coding for a sequence of amino acids in a polypeptide chain
- 1.2.9 Describe the basic structure of an amino acid (structure of specific amino acids are not required). Describe the formation of polypeptides and proteins as amino acid monomers linked by peptide bonds in condensation reactions. Explain the significance of a protein's primary structure in determining its three-dimensional structure and properties as a globular or fibrous protein
- 1.2.10 Explain the mechanism of action and specificity of enzymes in terms of their three-dimensional structure and explain that enzymes are biological catalysts that reduce activation energy
- 1.2.11 Describe how enzyme concentrations and substrate concentrations can affect the rates of reactions and how the effect of enzyme concentration on reaction rate can be investigated practically
- 1.2.12 Describe the process of DNA replication (semi-conservative, including the role of DNA polymerase)
- 1.2.13 Explain how errors in DNA replication can give rise to mutations and explain how CF results from one of a number of possible gene mutations
- 1.2.14 Explain the terms genotype, phenotype, recessive, dominant, homozygote and heterozygote and use a knowledge of genetics (including the interpretation of pedigree diagrams) to answer questions about monohybrid inheritance including CF, albinism, thalassaemia and garden pea height and seed morphology
- 1.2.15 Explain how the expression of the CF gene impairs the functioning of the gaseous exchange, digestive and reproductive systems
- 1.2.16 Describe the principles of gene therapy and distinguish between somatic and germ line therapy
- 1.2.17 Describe how gel electrophoresis can be used to separate DNA fragments of different length
- 1.2.18 Describe how the genetic profiles produced by gel electrophoresis can be used in genetic screening using gene probes
- 1.2.19 Explain the uses of genetic screening in the identification of carriers, prenatal testing (amniocentesis and chorionic villus sampling) and embryo testing
- 1.2.20 Discuss the social, ethical, moral and cultural issues related to genetic screening.

Unit 2: Development, Plants and the Environment

This unit comprises the following two topics: Topic 3 – The voice of the genome and Topic 4 – Plants and climate change. Knowledge of the topics already covered in Unit 1 will be assumed where this is relevant.

Topic 3: The voice of the genome

This topic follows the story of the development of multicellular organisms from single cells to complex individuals. The contribution of the Human Genome Project to our understanding of human genes and gene action is stressed. Cell structure and ultrastructure, cell differentiation, tissue organisation, cell division, the control of development, the roles of stem cells, gene expression and the importance of fertilisation are all taught within this topic.

Learning outcomes 2.3.4 and 2.3.12 link to learning outcomes 1.2.12 and 1.2.7 respectively.

Learning outcomes

Students should be able to:

- 2.3.1 Describe the ultrastructure of a typical eukaryotic cell (nucleus, ribosomes, rough and smooth endoplasmic reticulum, mitochondria, centrioles, lysosomes, nucleolus)
- 2.3.2 Explain the role of the rough endoplasmic reticulum (rER) and the Golgi apparatus in protein trafficking within cells
- 2.3.3 Distinguish between the ultrastructures of eukaryotic and prokaryotic cells
- 2.3.4 Explain the role of DNA replication and mitosis in the cell cycle
- 2.3.5 Explain the significance of mitosis for growth and asexual reproduction
- 2.3.6 Describe the stages of mitosis and how they can be observed practically
- 2.3.7 Explain how mammalian gametes are specialised for their functions including the acrosome reaction
- 2.3.8 Explain the importance of fertilisation in sexual reproduction
- 2.3.9 Explain how meiosis results in the halving of chromosome numbers and the introduction of variation through random assortment (the stages of meiosis, crossing over chiasmata are not required)
- 2.3.10 Explain what is meant by stem cells, pluripotency and totipotency
- 2.3.11 Discuss the moral, ethical and spiritual implications of stem cell research
- 2.3.12 Explain how genes can be switched on and off by DNA transcription factors and how this gene switching gives rise to specialised cells
- 2.3.13 Describe how the expression of a gene can be demonstrated practically by induction of β galactosidase
- 2.3.14 Explain how certain characteristics may be affected by both genotype and the environment, including human height, skin colour, hair colour and cancers
- 2.3.15 Explain that cancers arise from uncontrolled cell division (detailed knowledge of the checkpoint control in the cell cycle is not required) and describe genetic, environmental and lifestyle causes of cancer
- 2.3.16 Discuss the principal outcomes of the Human Genome Project and the social, moral and ethical issues which arise from it.

Topic 4: Plants and climate change

The topic begins by focusing on how plants overcome the problems associated with being rooted in one spot and investigates how we have exploited their solutions. It has sections on both traditional and novel uses of plants, including plant fibres and their uses, the use of plant extracts, genetic modification of plants and biodegradable starch packaging. General biological principles covered include the relationship of anatomy to functioning, the transport of water through plants, the role of starch and the controversy surrounding genetically modified plants. The effects of climate change on plants and animals are considered.

Learning outcome 2.4.2 links to learning outcome 2.3.1.

Learning outcome 2.4.3 links to learning outcome 1.1.12.

Learning outcome 2.4.21 links to learning outcomes 1.2.10 and 1.2.11.

Learning outcomes

Students should be able to:

- 2.4.1 Explain the importance of water and inorganic ions (nitrate, calcium and magnesium) to plants
- 2.4.2 Recall the typical ultrastructure of animal cells and contrast this with the ultrastructure of typical plant cells (presence of cell wall), chloroplasts, amyloplasts (containing starch grains), vacuole, tonoplast, plasmodesmata, pits and middle lamellae
- 2.4.3 Compare the structure and function of the polysaccharides starch and cellulose including the role of hydrogen bonds between β glucose molecules in the formulation of cellulose microfibrils
- 2.4.4 Describe the structure of sclerenchyma fibres and xylem vessels and where they are found in the plant stem. Describe how their physical properties enable them to be used for human benefit
- 2.4.5 Explain the relationship between structure and function in sclerenchyma fibres (support) and in xylem vessels (support and transport of water and mineral ions through the stem)
- 2.4.6 Explain the role of adhesion, cohesion and the transpiration stream in the movement of water through the stem
- 2.4.7 Describe how to determine the strength of fibres
- 2.4.8 Compare how William Withering developed his digitalis soup with drug developing and testing nowadays
- 2.4.9 Describe how to investigate the antibacterial properties of plants.
- 2.4.10 Relate the structure of seeds to their role in the dispersal and survival of the plant (adaptations for dispersal, protection and nutrition of the embryo)
- 2.4.11 Describe uses of starch and plant oils for humans (diet, packaging, glues, absorbent materials, fuels) and explain how the use of plant products can make resource utilisation more sustainable
- 2.4.12 Explain how the genetic modification of plants is similar to but distinct from conventional breeding
- 2.4.13 Discuss the scientific arguments for and against the use of genetically engineered plants (improved plant quality, enhanced yield and consequences for the environment and health)
- 2.4.14 Discuss the social and ethical arguments for and against the use of genetically engineered plants

- 2.4.15 Outline the causes of global warming – including the role of green house gases in the green house effect. Describe the sources of carbon dioxide and methane CH₄, their possible role in global warming and how their levels might be controlled
- 2.4.16 Recall the role of the carbon cycle in regulating atmospheric carbon dioxide levels and discuss the methods that can help to reduce atmospheric levels of carbon dioxide (including the use of biofuels and reforestation)
- 2.4.17 Discuss the possible relationship between CO₂ levels and global warming and how this can be investigated practically
- 2.4.18 Describe and analyse data from different types of evidence for and against global warming including temperature records, pollen in peat bogs and dendrochronology and appreciate that scientific theories must be supported by evidence
- 2.4.19 Appreciate that data can be extrapolated to make predictions, that these are used in models of future climate change, and that these models have limitations
- 2.4.20 Explain how climate change (rising temperature, changing rainfall patterns and changes in seasonal cycles) can affect plants and animals (distribution of species, development and life cycles)
- 2.4.21 Explain the effect of increased temperature on the rate of enzyme activity
- 2.4.22 Describe how to investigate the effects of temperature on the development of organisms (eg plant growth or brine shrimp hatch rates)
- 2.4.23 Discuss the way in which scientific conclusions about controversial issues can sometimes depend on who is reaching the conclusions, including their ethical and cultural perspectives.

Unit 3: Report and Practical Review

Introduction

The assessment of practical work for GCE AS in Unit 3 contributes 30 percent of the full AS qualification, as shown on page 5. The Visit or Issue Report and the Practical Work Review in Unit 3 are designed to show progression from GCSE to AS standard.

Teachers should make the assessment criteria available to students to enable them to understand what is expected of them.

Students are expected to follow the conventions, for the collection and presentation of data, set out in the document issued by the Institute of Biology: *Biological Nomenclature – Standard terms and expressions used in the teaching of biology*, (Third Edition, 2000, Institute of Biology, ISBN: 0900490365, or visit www.iob.org).

Edexcel will issue centres with exemplar practical assessment material for Unit 3 Paper 01 Visit or Issue Report and Paper 02 Practical Work Review.

Training meetings will be held to support teachers in the application of the practical assessment criteria. In addition, there will be a consultancy service available, please contact the Assessment Leader for GCE Biology at Edexcel (0870 240 9800) for further information.

Re-sit opportunities are available for Unit 3. Students may re-sit the whole of Unit 3 ie resubmit a new Visit or Issue Report and re-sit the Practical Work Review or they may retain their mark for the Visit or Issue Report and only re-sit their Practical Work Review. They may not, however, retain the mark for their Practical Work Review and resubmit another Visit or Issue Report.

Paper 01	Visit or Issue Report	20 marks
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Students will present a written report of around 1500 words (maximum 2000) words which will be marked by Edexcel. The report may be a record of a visit to a site of biological interest, or a report of non-practical research into a biological topic. This need not be related to the specification content. The visit or issue addressed is intended to bring a student into contact with a 'real-life' example of biology in use. Students will be assessed on their ability to identify two aspects of biology they observed in the context of their visit or while researching their issue. For each aspect students should describe the purpose for which, or significance of, the biology being used and to present the relevant information clearly and logically. An account of the biological principles being used is required for one of the two aspects they have identified. The visit or issue report also provides students with opportunities to demonstrate competence in key skills, both through the work they produce for their written report, and through other aspects of the work they carry out.

The report must be word processed and submitted to Edexcel by mid-May. The exact submission date is given in the introduction to the main examination timetable and can be found at www.edexcel.org.uk. This component will be marked by Edexcel.

Students should take part in at least one visit or identify an issue on which to report.

Organisation of the visit

The visit may take a variety of forms, provided it gives students an opportunity to meet the assessment criteria given on pages 26-29, there are no restrictions on the nature of the visit.

Some teachers may wish to arrange a whole-class visit to an industrial or research institution, some students may prefer to make their own arrangements to visit a local venue such as a hospital, garden centre or supermarket. However the visit is arranged, teachers should ensure that students are aware of the criteria by which their work will be assessed and ensure that these criteria may be met under the particular circumstance of the proposed visit(s).

Teachers will generally need to contact the chosen venue well in advance of the visit. In some cases an initial approach by the teacher will be followed up by students making their own contact. Whatever the nature of the visit, it is essential to ensure that students will be able to observe biology at a level appropriate for AS students and that due regard is paid to health and safety. Students are expected to explore the biology they observe during their visit and this exploration should contribute to their reports. The report must show evidence obtained from a range of sources and be presented to a named target audience. A student who has asked biology-related questions during the visit, kept a record of biology observed and discussed, and read any literature supplied by the venue, should be able to meet the relevant assessment criteria.

Organisation of the issue

Students are to select an issue on which to base their report. In the teaching of Units 1 and 2 the specification raises issues relating to biology in a contemporary setting and students may choose to explore one of these further. Whatever issues the students have identified, teachers should check that students are aware of the criteria by which their work will be assessed and ensure that these criteria may be met for the issues chosen.

The report must show evidence sought from a range of sources and be presented to a named target audience. Students are expected to explore the biology they identify when reflecting on their chosen issue and this exploration should contribute to their reports. A student who has identified an issue, researched and read the relevant literature from a range of sources, and discussed it with others where appropriate, should be able to meet the relevant assessment criteria.

The report of the visit or issue

Students are required to write a report that should demonstrate knowledge of AS biology. Students could, for example, write an article for a school magazine or a local paper. The report should be written assuming that readers have knowledge of biology to at least GCSE A*–C standard.

The report will:

- have a clear structure
- be written using technical vocabulary correctly, where appropriate
- incorporate visual methods of presentation
- acknowledge any artwork or photographs from other publications or websites
- demonstrate due care with the clear and correct use of English
- be word processed
- be around 1500 words (maximum 2000) excluding text attached to any diagrams, figures, graphs, data tables and the bibliography.

Illustrations might include computer-generated artwork or scanned examples of students' hand-drawn artwork, or students' own photographs.

Students should be allowed a period of at least two to three weeks following the identification of the issue or of making the visit to write and submit their reports. The report will be marked out of a total of 20 marks under criteria A, B and C on pages 26-27. A mark of 0 will be given if the work submitted is unworthy of any credit. When a student fails to submit work by the due date specified by the centre, this should be indicated by recording A (for absence) in the mark record.

Assessment criteria for the visit or issue report

A: Identifying and describing two aspects of biology

Students should clearly identify two aspects of biology that they observed in the context of the visit or while researching their chosen issue. For each aspect, students should describe the purpose for, or significance of, the biology which is being used. They should demonstrate an ability to recognise biological facts, terminology, principles, relationships, concepts and practical techniques. They should demonstrate an understanding of the ethical, social, economic or environmental implications of the biology encountered within the context of the visit or issue.

Identifying and describing two aspects of biology	4 marks
<ul style="list-style-type: none"> a The purpose or significance of two aspects of biology are described within the context of the chosen visit or issue. b There is some appreciation of the ethical, social, economic or environmental implications of the biology encountered within the context of the visit or issue. 	2 marks
<ul style="list-style-type: none"> a The significance of both aspects of biology are described clearly within the context of the chosen visit or issue. b There is a clear explanation of the ethical, social, economic or environmental implications of the biology encountered within the context of the visit or issue. 	4 marks

B: Account of biological principles

Students should show that they have explored one aspect of the biology they identified in section A, which they observed in the course of the visit or while researching their chosen issue. This may be through questioning ‘experts’, reading relevant literature or through their own thinking and speculation. They should give an accurate account of this aspect of biology referring to biological principles and concepts.

Account of biological principles	12 marks
<ul style="list-style-type: none"> a There is a description of the biology relevant to their chosen aspect. b There is a reference to future developments or uses in this area of biology. c There is reference to information or arguments obtained from three or more sources. 	3 marks

<ul style="list-style-type: none"> a There is a clear description of the biology relevant to their chosen aspect. b There is some speculation as to future developments or uses in this area of biology. c There is reference to the validity of the information or arguments obtained from three or more sources. 	6 marks
<ul style="list-style-type: none"> a There is a discussion showing some understanding of the biology relevant to their chosen aspect. b There is informed speculation as to future developments or uses of biology in this area of biology. c There is some evaluation of the validity of the information or arguments obtained from three or more sources. 	9 marks
<ul style="list-style-type: none"> a There is a clear discussion showing a thorough understanding of the biology relevant to their chosen aspect. b There is discussion of possible implications of future developments or uses in this area of biology. c There is a clear evaluation of the relative validity of the information or arguments obtained from three or more sources. 	12 marks

C: Communication

Students should produce a well-organised and clear report. They should select, organise and present information clearly and logically, present their work appropriately, select and use images to illustrate points clearly, and use standard conventions of spelling, punctuation and grammar. Sources should be listed in a bibliography, including website references sufficiently detailed so the appropriate page can be viewed. Quotes from printed material should be clearly identifiable as such and should not be excessive in length.

Communication	4 marks
<ul style="list-style-type: none"> a) The organisation and layout of the report shows evidence of some planning for the intended audience, with use of some appropriate graphs, tables, diagrams or photographs and technical terms used mostly correctly, where appropriate. b) Spelling, punctuation and grammar are largely correct, all sources used are acknowledged and not used excessively and the presentation is mostly clear and logical. This is the maximum mark available for reports which exceed 1500 words. 	2 marks
<ul style="list-style-type: none"> a) The organisation and layout of the report is well planned for the target audience and is enhanced by carefully selected graphs, tables, diagrams or photographs and correct use of appropriate terminology where appropriate. Sub-headings of graphs, diagrams and tables are appropriate and helpful. b) Spelling, punctuation and grammar are correct, all sources used are fully acknowledged and used selectively and the presentation is logical and concise. The report is within the word limit of 2000 words. 	4 marks

Paper 02**Practical Work Review****20 marks**

The Practical Work Review assesses the knowledge and experimental and investigative skills developed during the GCE AS course. Edexcel will distribute the Practical Work Review to centres on a specified date, up to four weeks prior to the submission date. Students should be given a supervised period, of up to one hour, in which to complete the paper. They should be given the paper not more than seven days before this supervised time to prepare for their writing.

In order to complete the Practical Work Review students will need to refer to their portfolio of completed practical accounts. It is recommended that, for a summer examination, students should have completed their portfolio of practical accounts by the beginning of the summer term. Having received and read carefully through the Practical Work Review, students will need to decide which two practical accounts to use as evidence in answering Questions 2 and 3. They may refer to their core practicals or other practical work they have carried out during their study of Units 1 and 2.

The Practical Work Review contains three questions each worth six or seven marks.

Question 1 will test students' knowledge and understanding of the practical skills and of the techniques they have carried out during the core practical work in Units 1 and 2. The core practicals are underlined in the content section of the specification.

Questions 2 and 3 will assess students' knowledge and understanding of the practical skills identified below. They must refer to their two chosen practical accounts in completing these sections of the Practical Work Review.

Experimental and investigative assessment objectives**1 Safety and use of apparatus**

Students should:

- a be able to comment critically on the suitability of apparatus for carrying out specific practical tasks in order to achieve measurements appropriate to the investigation
- b have an awareness of safety in the use of apparatus
- c during their practical work, consider the ethical issues arising from the use of living organisms and for the environment.

This could be in the context of an evaluation of practical work they have taken part in or when planning a new investigation.

2 Producing reliable and valid results

Students should:

- a appreciate that appropriate observations have to be made to validly test a hypothesis or idea
- b appreciate that variables need to be identified, including both dependent and independent variables, and, where possible, controlled or otherwise allowed for
- c be aware that valid results are derived through precise, repeatable measurements or observations, made with apparatus and experimental procedures that are suitable for the task
- d be aware that errors in readings can be systematic (values differing from the true value by the same amount) or random (values lying equally above or below the true value).

3 Significance of results/data

Students should realise that the significance of differences or trends within data is dependent on the degree of error within the experiment.

4 Presenting data

Students should be able to discuss the most appropriate methods for presenting data in order to identify trends and patterns clearly, and to an appropriate degree of accuracy.

5 Using results to draw conclusions

Students should appreciate that statements, explaining the trends and patterns in data from an investigation, should be supported by evidence from the data and their own biological knowledge. The validity of a conclusion is dependent on the experimental method used and the quality of the results obtained.

The review will require students to refer to the accounts they have made of the practical activities carried out in Units 1 and 2. Students may have to include examples of data tables, graphs or other relevant information in carrying out their Practical Work Review. They will have to submit to Edexcel the completed Practical Work Review and the complete accounts of two practical activities that have been used as evidence.

Administration

The completed Practical Work Review will be time-tabled during the normal summer examination period and the two selected practical accounts must be handed in with the question paper. The Practical Work Reviews of all students will be marked by an examiner appointed by Edexcel. The two practical accounts submitted as evidence will not normally be marked.

Unit 4: Environment and Survival

This unit comprises the following topics: Topic 5 – On the wild side and Topic 6 – Infection, immunity and forensics. Knowledge of the topics already covered in Units 1 and 2 will be assumed where this is relevant.

Topic 5: On the wild side

This topic begins with crisis that faces biodiversity and looks at the role of classification in cataloguing the diversity of life. It then goes on to consider genetic diversity and ecological diversity. This provides students with an understanding of how ecosystems work. This builds an appreciation that photosynthesis is the primary process which underpins the majority of ecosystems and leads on to how organisms are adapted to their environments. The topic continues by looking at how the diversity of life has arisen through natural selection and evolution. Students then study how ecosystems and their biodiversity can be protected through *in situ* and *ex situ* conservation, in particular by looking at the changing role of zoos. Students will see that successful conservation requires an understanding of the interactions between wildlife and human populations as well as a scientific knowledge of both genetics and ecology. By the end of the topic students will be able to appreciate how scientific understanding can make us aware of our responsibilities as stewards of the environment.

Learning outcome 4.5.3 links to learning outcomes 1.2.14.

Learning outcome 4.5.5 links to learning outcome 2.4.20.

Learning outcome 4.5.12 links to learning outcome 1.2.13.

Learning outcomes

Students should be able to:

- 4.5.1 Explain the principles of taxonomy and its significance in addressing the challenges faced by the scientific community in cataloguing biodiversity. Describe how keys are used for identification purposes. Students only need to know the features of the five kingdoms, but should appreciate that other classification systems exist (details of other taxonomic groups are not required).
- 4.5.2 Explain what is meant by conservation of genetic diversity and explain how genetic diversity is generated through mutations and recombination of genes including independent assortment and crossing over
- 4.5.3 Explain the inheritance of characteristics controlled by alleles at two loci. Students should be able to construct and interpret genetic diagrams for dihybrid crosses (linkage is not required)
- 4.5.4 Describe how to carry out a study on the ecology of a named terrestrial or semi-terrestrial habitat (including the use of quadrats and transects to assess abundance and distribution of organisms and the measurement of abiotic factors to include soil factors, temperature, humidity and aspect.)
- 4.5.5 Explain the distribution of organisms in the habitat named in terms of biotic and abiotic factors measured and considered
- 4.5.6 Discuss the adaptations of one species in each of the trophic levels in a habitat they have studied
- 4.5.7 Explain the light dependent reactions of photosynthesis in C₃ plants including how light energy is trapped by exciting electrons in chlorophyll and the role of these electrons in generating ATP, reducing NADP and producing oxygen through photolysis

- 4.5.8 Explain the light-independent reactions in C3 plants as reduction of carbon dioxide using the products on the light-dependent reactions (fixing of carbon dioxide in the Calvin cycle the role of GP, GALP and RuBP). Describe the products as simple sugars which are used by plants, animals and other organisms in respiration and the synthesis of new biological molecules
- 4.5.9 Describe the structure of chloroplasts in relation to their role in photosynthesis
- 4.5.10 Explain the relationship between gross primary productivity, net primary productivity and plant respiration
- 4.5.11 Carry out calculations to determine the efficiency of energy transfers between trophic levels
- 4.5.12 Describe how natural selection can lead to evolution through gene mutation and changes in allele frequencies
- 4.5.13 Discuss the historical development of the theory of evolution with reference to the work of Darwin, Wallace, Lamarck and Malthus
- 4.5.14 Explain how reproductive isolation can lead to speciation
- 4.5.15 Appreciate why, for cultural reasons, the theory of evolution has been so controversial for some people
- 4.5.16 Describe the concept of succession to a climax community
- 4.5.17 Discuss the extent to which zoos can play a role in the conservation of endangered species (scientific research, captive breeding programmes, reintroduction programmes and education)
- 4.5.18 Discuss ways in which conflicts between wildlife and humans can be reconciled and the social and cultural issues involved
- 4.5.19 Discuss how cultural issues are reflected in the legislation which drives UK and international initiatives that use biological principles to manage conservation and development sustainably.

Topic 6: Infection, immunity and forensics

This topic starts by looking at how forensic pathologists use a wide variety of analytical techniques to determine the cause of death of organisms, including humans, and to establish the time which has elapsed since death occurred. It then considers how bacteria and viruses use a variety of routes into their hosts and how hosts have evolved barriers and internal mechanisms to combat infections. These protections are not always successful and many people in the world still die from infectious diseases. This topic also investigates the evolutionary battles that take place between invading pathogens and their hosts.

Learning outcome 4.6.3 links to learning outcome 4.5.16.

Learning outcome 4.6.4 links to learning outcome 2.3.3.

Learning outcomes

Students should be able to:

- 4.6.1 Describe how forensic pathologists determine the time of death (extent of decomposition, forensic entomology, body temperature, degree of muscle contraction)
- 4.6.2 Describe how forensic pathologists determine the identity of a dead person (physical resemblance, DNA fingerprinting, dental records)
- 4.6.3 Interpret data on the typical stages of succession on dead bodies

- 4.6.4 Distinguish between the structure of bacteria and viruses
- 4.6.5 Describe the course of tuberculosis (TB) as an instance of a bacterial infection and of Human Immunodeficiency Virus (HIV) as an instance of viral infection
- 4.6.6 Explain how infectious diseases, as exemplified by TB and HIV, have a sequence of symptoms which may result in death
- 4.6.7 Describe the non-specific responses of the body to infection (inflammation, lysozyme action, interferon, phagocytosis)
- 4.6.8 Explain the roles of antigens and antibodies in the body's immune response including the involvement of plasma cells, macrophages, antigen-presenting cells and major histocompatibility complexes
- 4.6.9 Distinguish between the roles of B cells (B memory and B effector cells) and T cells (T helper, T killer and T memory cells) in the body's immune response
- 4.6.10 Explain the role of negative feedback in maintaining systems within narrow limits
- 4.6.11 Explain how an infectious disease, as exemplified by tuberculosis, can interfere with the body's negative feedback mechanisms for thermoregulation
- 4.6.12 Describe the major routes pathogens may take in entering the body and explain the role of barriers in protecting the body from infection (skin, stomach acid, gut and skin flora)
- 4.6.13 Explain how individuals may develop immunity (natural, artificial, active, passive)
- 4.6.14 Discuss how 'the evolutionary race' between pathogens and their hosts has resulted in sophisticated evasion mechanisms in Human Immunodeficiency Virus (HIV) and *Mycobacterium tuberculosis* (TB)
- 4.6.15 Distinguish between bacteriostatic and bactericidal antibiotics
- 4.6.16 Describe how to investigate the effect of different antibiotics on bacteria
- 4.6.17 Explain why antibiotic resistance in bacteria is an increasing problem
- 4.6.18 Discuss how an 'evolutionary race' exists between pathogens and drug developers.

Unit 5: Energy, Exercise and Coordination: Coursework Investigation

This unit comprises the following topics: Topic 7 – Run for your life and Topic 8 – Grey matter. Knowledge of the topics already covered in Units 1, 2 and 4 will be assumed where this is relevant.

Topic 7: Run for your life

This topic is centred on the physiological adaptations that enable humans, particularly sports people, and other animals to undertake strenuous exercise. It explores the links between an animal's physiology and its performance. The topic summarises the biochemical requirements for respiration and looks at the links between homeostasis, muscle physiology and performance. It ends by looking at how medical technology is enabling more people to participate in sport, and by raising the issue as to whether the use of performance enhancing substances by athletes can be justified.

Learning outcomes 5.7.3 and 5.7.6 link to learning outcomes 4.5.7 and 4.5.8.

Learning outcome 5.7.8 links to learning outcome 1.1.1.

Learning outcome 5.7.12 links to learning outcome 4.6.10.

Learning outcomes

Students should be able to:

- 5.7.1 Recall the way in which muscles, tendons, the skeleton and ligaments interact to enable movement including antagonistic muscle pairs, extensors and flexors
- 5.7.2 Explain the contraction of skeletal muscle in terms of the sliding filament theory (including the role of actin, myosin, troponin, tropomyosin, Ca^{2+} , ATP)
- 5.7.3 Explain how phosphorylation of ATP requires energy and how dephosphorylation of ATP provides an immediate supply of energy for biological processes
- 5.7.4 Describe the roles of glycolysis in aerobic and anaerobic respiration, starting with phosphorylation of glucose and ending with pyruvate (names of other compounds are not required)
- 5.7.5 Describe the role of the Krebs cycle in the complete oxidation of glucose and formation of CO_2 , ATP, reduced NAD and reduced FAD (names of other compounds are not required)
- 5.7.6 Describe the synthesis of ATP by oxidative phosphorylation associated with the electron transport chain in mitochondria including the role of chemiosmosis
- 5.7.7 Explain the fate of lactate after a period of anaerobic respiration in mammals
- 5.7.8 Explain how variations in ventilation and cardiac output enable efficient delivery of oxygen to tissues and removal of carbon dioxide from them, including how the heart rate and ventilation rate are controlled and the roles of the cardiovascular control centre and the ventilation centre
- 5.7.9 Describe how to investigate the effects of exercise on tidal volume and breathing rate (knowledge of spirometer will not be assumed)

- 5.7.10 Discuss why some animals are better at short bursts of high intensity exercise while others are better at long periods of continuous activity
- 5.7.11 Describe the structural, and explain the physiological, differences between fast and slow twitch muscle fibres
- 5.7.12 Discuss the concept of homeostasis and its importance in maintaining the body in a state of dynamic equilibrium during exercise as exemplified by thermoregulation, including the role of the heat loss, heat gain centres and mechanisms for controlled body temperature
- 5.7.13 Discuss possible disadvantages of exercising too much (wear and tear on joints, suppression of the immune system) and exercising too little (increased risk of obesity, CHD and diabetes)
- 5.7.14 Explain how medical technology, including the use of key-hole surgery and prostheses, is enabling those with injuries and disabilities to participate in sports
- 5.7.15 Discuss whether the use by athletes of performance enhancing substances, including creatine, testosterone and erythropoetin, is morally and ethically acceptable.

Topic 8: Grey matter

The scene is set by considering how the working of the nervous system enables us to see. Brain imaging and the regions of the brain are considered. The topic also demonstrates how an understanding of brain structure and functioning is relevant to such issues as the response to stimuli, the development of vision and learning. The methods which are used to compare the contributions of nature and nurture to brain development will be covered and the role of genetics and animal models in understanding brain structure will be examined. The topic requires students to discuss the ethics of using animals for medical research. How imbalances in brain chemicals may result in conditions such as Parkinson's disease are investigated.

Learning outcome 5.8.7 links to learning outcome 4.6.10.

Learning outcome 5.8.13 links to learning outcome 2.3.11.

Learning outcome 5.8.16 links to learning outcome 4.5.3 and 1.2.14.

Learning outcomes

Students should be able to:

- 5.8.1 Describe the structure and function of sensory, relay and motor neurones including the role of Schwann cells and myelination
- 5.8.2 Explain how the nervous systems of organisms can cause effectors to respond as exemplified by pupil dilation and contraction
- 5.8.3 Describe how a nerve impulse (action potential) is conducted along an axon including changes in membrane permeability to sodium and potassium ions and the role of the nodes of Ranvier
- 5.8.4 Describe the structure and function of synapses including the role of neurotransmitters (including acetylcholine)
- 5.8.5 Describe how the nervous systems of organisms can detect stimuli with reference to rods in the retina of mammals, the roles of rhodopsin, opsin, retinal, Na⁺ ions, cation channels and hyperpolarisation of rod cells in forming action potential in the optic nerve

- 5.8.6 Compare and contrast nervous and hormonal coordination (details of individual hormones are not required)
- 5.8.7 Locate and state the functions of the regions of the human brain's cerebral hemispheres (ability to see, think, learn and feel emotions), hypothalamus (thermoregulate), cerebellum (co-ordinate movement) and medulla oblongata (control the heartbeat)
- 5.8.8 Explain how images produced by MRI, fMRI and CT scans can be used to investigate brain structure and activity
- 5.8.9 Discuss the evidence that there exists a critical 'window' within which humans must be exposed to particular stimuli if they are to develop their visual capacities to the full
- 5.8.10 Describe how to investigate visual perception in humans (pattern recognition, optical illusions eg the Müller-Lyer illusion)
- 5.8.11 Describe ways in which animals including humans can learn (habituation, classical conditioning, operant conditioning and insightful learning)
- 5.8.12 Describe the role animal models have played in understanding human brain development and function (Pavlov's dogs, Hubel and Wiesel's experiments with monkeys and kittens)
- 5.8.13 Discuss the moral and ethical issues related to the use of animals in medical research
- 5.8.14 Explain how imbalances in certain, naturally occurring, brain chemicals (dopamine, serotonin) can contribute to adverse consequences for health (Parkinson's disease, depression) and to the development of new drugs
- 5.8.15 Explain the effects of drugs on synaptic transmissions with particular reference to ecstasy (MDMA) and the use of L-Dopa in the treatment of Parkinson's disease
- 5.8.16 Explain that some characteristics are controlled by alleles at many loci (polygenic inheritance) and how this can give rise to phenotypes which show continuous variation
- 5.8.17 Consider the methods used to compare the contributions of nature and nurture to brain development (including evidence from the abilities of new born babies, animal experiments, studies of individuals with damaged brain areas, twin studies and cross-cultural studies).

Practical assessment in Unit 5

Introduction

In Unit 5 internal assessment contributes 10 percent of the full GCE Advanced qualification as shown on page 9.

The requirements at A2 level require further progression by the student as evidenced by the submission of an individual practical project, the Coursework Investigation in Unit 5.

Teachers should make the assessment criteria available to students to enable them to understand what is expected of them.

Students are expected to follow the conventions for the collection and presentation of data as set out in the following document issued by the Institute of Biology: *Biological Nomenclature – Standard terms and expression used in the teaching of biology*, (Third Edition, 2000, Institute of Biology) ISBN: 0900490365.

Edexcel will issue centres with exemplar practical assessment material for Unit 5 Paper 02 Coursework Investigation. Inset meetings will be held to support teachers in the application of the practical assessment criteria. In addition, there is a consultancy service available. Please contact 0870 240 9800, or the Assessment Leader for GCE Biology at Edexcel for further details.

Re-sit opportunities are available for Unit 5. Students may retake the whole of Unit 5, ie re-sit Paper 01 and resubmit a new Paper 02 Coursework Investigation, or they may retain their mark for the Coursework Investigation and re-sit Paper 01. They may not, however, retain their mark for Paper 01 and resubmit another Coursework Investigation.

Paper 02	Coursework Investigation	40 marks
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Students will present a written report (a maximum of 3000 words) of an experimental investigation they have devised and carried out. The Coursework Investigation in Unit 5 is an individual practical project which is designed to show progression from the Unit 3: Report and Practical Review in the AS course.

Each student is required to carry out an extended practical project, taking the equivalent of two weeks of normal lesson and homework time. Students will be assessed on their ability to plan and carry out experimental procedures, to interpret their experimental results, and to report on their work. The marks awarded for assessment criteria A, C and E are allocated to synoptic assessment and the work for these assessment criteria must fulfil the criteria for synoptic assessment in order for the marks to be awarded.

At all times during the project, from initial planning to writing up, students should be encouraged to discuss their ideas with their teachers. This is particularly important in the early stages when students are choosing the topics for their investigations. Teachers may offer general guidance without penalty but, where specific information is given, this must be taken into account when awarding marks. The writing of the report must be entirely the student's own work.

Assessment is based on written work produced by the student.

The report must include presentation and analysis of the student's own numerical data. The report must be word processed and submitted on disc or electronically. This report will be marked by the teacher. The reports from selected students will be inspected by a moderator appointed by Edexcel.

This assessment may be carried out at any time during the course, but the work should reflect the standard expected at Advanced GCE level. Note that half of the available marks are intended to be based on synoptic material.

Organisation

The Salters-Nuffield Advanced Biology website and course materials contain a number of suggested topics for investigation, and students can select one of these. However, the choice should not be restricted to these topics. Students may wish to suggest their own topics for investigation. Provided such investigations are linked to the content of the course and have the potential to allow students to meet all the assessment criteria given on pages 41–44, they should be encouraged.

Students must produce individual work. Two or more students may choose the same or similar topics, provided each works independently.

Normally laboratory or field work will be undertaken under the direct supervision of the teacher. If the nature of the investigation involves a student carrying out practical work outside the school or college environment, sufficient work must take place under direct supervision to allow the teacher to ensure that it is the student's own work. The teacher must discuss the practical aspects with the student to establish that the student did undertake the work personally. This might be done by asking about precise details of the work, the apparatus used, the practical problems encountered and how they were overcome.

Preparation

Students should do some background research for their coursework investigation. This research should help them identify and define a biological question or problem that can be addressed and provide a clear rationale for their work. They should consult appropriate sources, which may include textbooks, magazines and journals, CD Roms and the internet. Reports should include a bibliography of the sources consulted and references to electronic materials should give the date of access and contain sufficient detail to allow the reader to check the source.

In advance of the data collection phase, students should devise and plan their experimental activities to make good use of the time and facilities available. They should consider appropriate methods, choose effective and safe procedures and select suitable techniques. They should decide what apparatus they will need, and check that this will be available for their use. They may devise their own apparatus or experimental set-ups, modify standard apparatus or use standard items in ways that are novel.

Students should have some idea of how they expect the work to proceed but should also be prepared to modify their plan in the light of initial results. It is, therefore, advisable that students should carry out a brief trial, in advance of the main data collection phase, to check the feasibility of their proposed work.

Experimentation

Students are expected to use safe and skilful practical techniques that are appropriate to the purpose of the investigation and for the apparatus available. They should demonstrate an ability to set up apparatus correctly and use it effectively with due regard to safety.

Students should make sufficient and relevant observations and measurements, to an appropriate degree of precision, record these methodically, and modify procedures in order to generate results that are as accurate and reliable as allowed by the apparatus and investigative approach.

Students should interpret, explain and evaluate the results of their experimental activities using knowledge and understanding of biology. They should present their results appropriately in written, graphical or other forms. They should analyse their results statistically and draw conclusions, showing an awareness of the limitations of their experimental data and the procedures used.

The report

Each student is required to produce a project report. Students should be encouraged to start work on their reports before they have completed their practical work. They should be allowed a further period of at least two to three weeks to produce their reports after they have completed their collection of data. The report must be word processed, and submitted on disc or, preferably, electronically.

Students should aim to produce well-organised and clear reports. They should select, organise and present information clearly and logically, present their work appropriately, select and use images to illustrate points clearly, and use standard conventions of spelling, punctuation and grammar. The report should be in the style of a scientific paper. Sub-headings should be used to aid organisation. The initial aim of the project should be stated clearly, as should any overall conclusions that have been drawn. The report should include a bibliography listing all reference sources consulted.

Graphs, tables and diagrams should be used where they add to the clarity and conciseness of the report.

The report can be up to 3000 words including abstract, trial, bibliography, tables/captions, appendices and any other text. Reports that are longer than this cannot achieve full marks as shown in the assessment criteria. Credit will be given to reports which are clear and concise, which show good use of English and appropriate biological terminology.

The investigation is marked out of a total of 40 marks, using the criteria given on pages 39-42.

Intermediate marks (eg 1, 3, 5) should be used when students have partially achieved a listed mark level of the criteria, but half-marks should not be used. Note that for each aspect, the criteria are hierarchical: for a mark to be awarded, all of the earlier mark levels must have been satisfied. A mark of 0 should be awarded if the work submitted is unworthy of any credit. When a student fails to submit work by the due date specified by the centre, this should be indicated by recording A (for absence) in the mark record. Where more than one teacher has been involved, centres must make arrangements for internal moderation to be carried out, and details of this procedure must be available for the Edexcel moderator if requested.

It is the responsibility of the teacher to ensure that the report submitted from each student is produced individually. In submitting the authentication certificate teachers accept the responsibility for ensuring that these conditions have been met.

Students must also attach and submit the authentication certificate in *Appendix 4* on page 82 to confirm that the work they submit is their own unaided work.

Assessment Criteria for the Coursework Investigation

A: Research and rationale	8 marks
<p>a There is some attempt to provide a rationale for the choice of investigation in terms of its scope and its relation to biological principles.</p> <p>b Few sources are consulted and their scope is limited in providing a context for the investigation, to assist with the planning or execution of laboratory or field work, or in informing the interpretation of results.</p>	2 marks
<p>a There is a partial rationale for the choice of investigation. The biological background to the investigation is developed to some extent.</p> <p>b Information gathered from some relevant sources has some bearing on the context for the investigation, and assists, in a limited way, with the planning or execution of laboratory or field work, or to inform the interpretation of results.</p>	4 marks
<p>a The rationale for the investigation is clear, in terms of its scope and relationship to biological principles.</p> <p>b Several relevant sources are consulted, and are used to provide a context for the project, to assist with the planning or execution of laboratory or field work, and to inform the interpretation of results.</p>	6 marks
<p>a The rationale for the investigation is clearly justified in terms of its scope and appropriate biological principles are discussed.</p> <p>b Additional sources, beyond those that were most readily to hand or were initially suggested by the teacher are selected. The material chosen is selected for its relevance to the investigation and it is used effectively to provide a context for the project, to assist with the planning or execution of laboratory or field work, and to inform the interpretation of results.</p>	8 marks

B: Planning	8 marks
<p>a There is some attempt to plan and to select the method or apparatus chosen. Some relevant variables are identified.</p> <p>b Some potential safety hazards and the steps to avoid or minimise them are identified.</p> <p>c A trial experiment may be carried out.</p>	2 marks
<p>a There is a plan for the investigation, with some explanation of the selection of apparatus and methods. There are some details of how variables are to be controlled, manipulated or taken into account and how relevant observations are to be made.</p> <p>b Most potential safety hazards, and the steps to avoid or minimise them, are identified.</p> <p>c A trial experiment is performed that has some bearing on the planning of the project.</p>	4 marks

<p>a There is a clear plan of action, both for an initial trial phase and for the main period of data collection. Apparatus selected and methods chosen are appropriate to the investigation. There is discussion about how variables are controlled, manipulated or taken into account and about the collection of relevant observations or data.</p> <p>b All potential safety hazards are identified, and suitable steps taken to avoid or minimise them.</p> <p>c A well-thought out trial is conducted in advance of the main data collection phase, and is used to inform the planning of the investigation.</p>	6 marks
<p>a, b, c) There is evidence of thought and ingenuity in the design of experiments or the recording of data, with good attention to detail including the way in which variables are controlled, manipulated or taken into account and how relevant observations are made or data collected. Apparatus is devised or modified to suit the project as necessary.</p>	8 marks

C: Implementing	6 marks
<p>a Apparatus is used with some skill and attention to health and safety.</p> <p>b Some previously learned techniques and procedures are carried out appropriately.</p> <p>c The initial plan has some bearing on the execution of the work.</p>	2 marks
<p>a Apparatus is generally used appropriately and with confidence, care and skill.</p> <p>b Techniques are usually applied correctly and extended or modified if necessary. Work is generally methodical and well-organised.</p> <p>c There is some reviewing of the initial plan as the project proceeds.</p>	4 marks
<p>a Apparatus is used confidently, carefully and skilfully. There is good awareness of health and safety and all reasonable steps taken to minimise risk throughout the investigation.</p> <p>b Techniques are always applied correctly and extended or modified if necessary. Work is always methodical and well-organised.</p> <p>c The initial plan is reviewed frequently in the course of the project, and modified or maintained according to results obtained.</p>	6 marks

D: Observing and recording	6 marks
<p>a Some appropriate measurements and observations are recorded which are adequate for the method used and reasonably accurate.</p> <p>b There is some repeating or checking of values obtained.</p>	2 marks
<p>a Measurements and observations are recorded methodically and accurately in appropriate units, and some thought is given to precision and repeatability.</p> <p>b A reasonable number and range of observations and measurements are carried out. Any anomalous results are noted. There is some appropriate modification of procedures for data collection if necessary.</p>	4 marks

<p>a Observations and measurements are carried out over a suitable range of values or conditions. Sufficient observations and measurements are made to allow a conclusion. Numerical results are recorded to an appropriate degree of precision.</p> <p>b Measurements and observations are repeated as appropriate. Any anomalous results are noted and investigated. If problems arise in the making of measurements or observations, procedures are adapted to ensure data are reliable.</p>	6 marks
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E: Interpreting and evaluating	6 marks
<p>a There is some data processing. Statistical analysis is only completed with detailed guidance. Application of calculated statistical values is present, though limited or confused.</p> <p>b There is an attempt to apply biological principles.</p> <p>c Some conclusions are stated. There is some awareness of the limitations of experimental results and conclusions.</p>	2 marks
<p>a Data are processed with some thought as to choice of method. The chosen statistical test(s) may be inappropriate or provide limited analysis of the stated hypothesis. Calculations are clearly set out but the interpretation of calculated values lacks detailed explanation. Some trends and patterns are identified.</p> <p>b Some attempt is made to interpret results using biological principles, and to draw conclusions based on experimental results.</p> <p>c Conclusions are supported by results. The limitations of results, and conclusions based upon them, are recognised. Any limitations of methods are recognised.</p>	4 marks
<p>a Data are processed using appropriate methods that reveal trends and patterns. The chosen statistical tests are appropriate to the data to be analysed and the hypothesis to be tested. Calculations of statistical tests are clearly set out and interpreted, using a null hypothesis and 5 per cent confidence levels where appropriate. Trends and patterns are identified.</p> <p>b Results are interpreted using biological principles and concepts of Advanced GCE standard. Relevant biological principles are applied correctly throughout.</p> <p>c Conclusions are supported by results. The limitations of results, and conclusions based upon them, are recognised and evaluated. Any limitations of the procedure are commented upon, and sensible modifications suggested.</p>	6 marks

F: Communicating	6 marks
<p>a The layout of the report largely conforms to that expected of a scientific paper. The organisation of the report produced shows evidence of some thought and the aim of the investigation is stated. Images, when used, are relevant to the points made.</p> <p>b Data are presented in graphs, tables or diagrams, which are mostly appropriate and follow scientific conventions for presentation.</p> <p>c Spelling, punctuation and grammar are generally correct, some technical terms are used appropriately and most sources used are acknowledged in a bibliography.</p>	2 marks
<p>a The layout of the report mostly conforms to that expected of a scientific paper with subheadings used effectively. The aim(s) and conclusion(s) of the investigation are stated. Images, when used, illustrate points clearly.</p> <p>b Data are presented in well-chosen graphs, tables or diagrams, which usually follow scientific conventions and mostly use SI units, where appropriate, correctly.</p> <p>c Spelling, punctuation and grammar are correct, appropriate technical terms are usually used and sources used are referred to within a properly constructed bibliography. This is the maximum mark for reports which exceed 3000 words.</p>	4 marks
<p>a The layout of the report conforms to that expected of a scientific paper with appropriate and helpful subheadings. The organisation of the report shows evidence of thoughtful planning and the aim(s) and conclusion(s) of the project are clearly stated and discussed. Images illustrate the points effectively and enhance the clarity of the report.</p> <p>b Data are presented effectively in graphs, tables or diagrams which follow scientific conventions and are clearly and accurately labelled using SI units where appropriate.</p> <p>c Spelling, punctuation and grammar are correct, and appropriate technical terms are used throughout. Sources are selected and used appropriately and are correctly and clearly referenced within a properly constructed bibliography. The report is within the word limit of 3000 words.</p>	6 marks

Administration of the coursework scheme for Unit 5

Coursework must be marked by the centre, using the criteria set out on pages 39-42. The written work must be marked by the teacher who has supervised the student. A coursework record should be annotated by the teacher to show how the marks have been awarded for each student. These record cards/sheets must be available for moderation and only this information and the electronic version of the report will be looked at by the moderator.

Teachers must keep records of assessment for each student during the course, using the electronic coursework record sheets provided by Edexcel (available from the Edexcel website) and printed for use in centres. The centre must certify that the assessed work is the unaided work of the student concerned. Students are also required to certify that the investigation is their own unaided work.

A Teacher Examiner Mark Sheet must be submitted to Edexcel for every student.

Internal standardisation

Where more than one teacher has been involved in the assessment of coursework, centres must make arrangements for internal standardisation. Internal standardisation should be supervised by a teacher nominated from those who have carried out the assessment, and should ensure that the assessment criteria have been applied consistently.

Centres will be required to verify to Edexcel that internal standardisation has taken place.

External moderation

Edexcel will appoint an external moderator to undertake the moderation of teachers' assessment of coursework by sampling student work. All coursework should be completed by the dates notified to centres, including internal standardisation of assessment. By the dates notified, the coursework marks of all students should be submitted to Edexcel via Electronic Data Interchange (EDI) or optically-read mark sheets supplied by Edexcel. The material to be used for moderation will consist of:

- a the completed coursework record sheet for the student in electronic format (available from the Edexcel website)
- b the student's report in electronic format
- c the student's authentication certificate (see *Appendix 4*, page 82).

Both (b) and (c) should be contained within student's own electronic folder.

The moderator will inspect a representative sample, and may look at more if necessary. Centres must retain a copy of students' work in case the moderator has problems accessing the files. Information about moderation procedures will be sent to centres making entries for this specification and will also be available from the Edexcel website.

Presentation of the specification by themes - AS

The learning outcomes for the AS specification are organised below according to biological theme. This enables teachers to identify how the learning outcomes in the Topics link together as themes, should this approach be helpful. Each learning outcome retains the same identifying numbers. There is a mapping document on page 55 to show the distribution of the fourteen themes through the AS and A2 units.

Theme 1: Transport

- 1.1.1 Explain why many animals have a heart and circulation (mass transport to overcome limitations of diffusion)
- 1.1.2 Explain how the structures of blood capillaries, arteries and veins relate to their functions
- 1.1.3 Relate the structure and operation of the mammalian heart to its function (the cardiac cycle including diastole, atrial systole and ventricular systole)
- 1.1.5 Describe the blood clotting process (thromboplastin release, conversion of prothrombin to thrombin and fibrinogen to fibrin) and its role in CVD
- 1.1.7 Describe what is meant by blood pressure and explain the role of high blood pressure in CVD
- 1.1.8 Describe the normal electrical activity of the heart, including the roles of the sino-atrial node (SAN), the atrio-ventricular node (AVN) and the bundle of His, and how the use of electrocardiograms (ECGs) can aid the diagnosis of CVD and other heart conditions
- 1.2.1 Describe the properties of gas exchange surfaces (large surface to volume ratio, thickness of surface, difference in concentration) and explain how the structure of the lung provides a large surface area to volume ratio
- 2.4.5 Explain the relationship between structure and function in sclerenchyma fibres (support) and in xylem vessels (support and transport of water and mineral ions through the stem)
- 2.4.6 Explain the role of adhesion, cohesion and the transpiration stream in the movement of water through the stem.

Theme 2: Health

- 1.1.5 Describe the blood clotting process (thromboplastin release, conversion of prothrombin to thrombin and fibrinogen to fibrin) and its role in CVD
- 1.1.6 Describe the symptoms of CVD, ie coronary heart disease (CHD) and stroke, and the factors which increase the risk of CVD (genetic, diet, age, gender, high blood pressure, smoking and inactivity)
- 1.1.8 Describe the normal electrical activity of the heart, including the roles of the sino-atrial node (SAN), the atrio-ventricular node (AVN) and the bundle of His, and how the use of electrocardiograms (ECGs) can aid the diagnosis of CVD and other heart conditions

- 1.1.9 Analyse quantitative data on illness and mortality rates to determine health risks and recognise that it is important to distinguish between correlation and causation
- 1.1.10 Explain why people's perceptions of risks are often different from the actual risks
- 1.1.11 Analyse data on energy budgets and diet so as to be able to discuss the consequences of energy imbalance
- 1.1.16 Discuss the possible significance for health of blood cholesterol levels and levels of high-density lipoproteins and low-density lipoproteins (HDLs and LDLs)
- 1.1.18 Discuss how individuals, by changing their diet, taking exercise and not smoking, can reduce their risk of coronary heart disease
- 1.2.16 Describe the principles of gene therapy and distinguish between somatic and germ line therapy
- 2.3.14 Explain how certain characteristics may be affected by both genotype and the environment, including human height, skin colour, hair colour and cancers
- 2.3.15 Explain that cancers arise from uncontrolled cell division (detailed knowledge of the checkpoint control in the cell cycle is not required) and describe genetic, environmental and lifestyle causes of cancer.

Theme 3: Biological Molecules

- 1.1.12 Distinguish between monosaccharides, disaccharides and polysaccharides (glycogen and starch – amylose and amylopectin) in terms of their structure and their role in providing and storing energy (β -glucose and cellulose are not required at this stage). Students should recognise the structural formulae for α -glucose and maltose and the monomers which make up sucrose and lactose
- 1.1.13 Describe how monosaccharides join to form polysaccharides through condensation reactions forming glycosidic bonds, and how these can be split through hydrolysis reactions
- 1.1.14 Recognise that glycerol with three fatty acids attached is a lipid and specifically a triglyceride, describe the formation of ester bonds in condensation reactions and recognise differences between saturated and unsaturated lipids
- 1.2.6 Describe the basic structure of mononucleotides as a phosphate group, deoxyribose or ribose and a base eg thymine, uracil, cytosine, adenine and guanine. Describe the structures of DNA and RNA as polynucleotides composed of mononucleotides linked in condensation reactions. Describe complementary base pairing and the hydrogen bonding involved in the formation of the DNA double helix
- 1.2.7 Explain the process of protein synthesis (transcription, translation, transfer RNA, messenger RNA, ribosomes, the role of start and stop codons) explain the roles of the template (antisense) DNA strand in transcription, codons on messenger RNA and anticodons on transfer RNAs
- 1.2.8 Explain the nature of the genetic code (triplet code, non-overlapping and degenerate) and describe a gene as being a sequence of bases on a DNA molecule coding for a sequence of amino acids in a polypeptide chain

- 1.2.9 Describe the basic structure of an amino acid (structure of specific amino acids are not required). Describe the formation of polypeptides and proteins as amino acid monomers linked by peptide bonds in condensation reactions. Explain the significance of a protein's primary structure in determining its three-dimensional structure and properties as a globular or fibrous protein
- 1.2.10 Explain the mechanism of action and specificity of enzymes in terms of their three-dimensional structure and explain that enzymes are biological catalysts that reduce activation energy
- 1.2.12 Describe the process of DNA replication (semi-conservative, including the role of DNA polymerase)
- 1.2.13 Explain how errors in DNA replication can give rise to mutations and explain how CF results from one of a number of possible gene mutations
- 2.4.3 Compare the structure and function of the polysaccharides starch and cellulose including the role of hydrogen bonds between β glucose molecules in the formulation of cellulose microfibrils
- 2.4.21 Explain the effect of increased temperature on the rate of enzyme activity.

Theme 4: Cell Biology

- 1.2.1 Describe the properties of gas exchange surfaces (large surface to volume ratio, thickness of surface, difference in concentration) and explain how the structure of the lung provides a large surface area to volume ratio
- 1.2.2 Describe the structure of the unit membrane (fluid mosaic model) and how its structure depends on the properties of the phospholipids
- 1.2.4 Explain what is meant by osmosis in terms of the diffusion of free water molecules through a partially permeable membrane (consideration of water potential is not required)
- 1.2.5 Explain what is meant by passive transport (diffusion, facilitated diffusion), active transport (including the role of ATP), endocytosis and exocytosis and describe the involvement of carrier and channel proteins in membrane transport
- 2.3.1 Describe the ultrastructure of a typical eukaryotic cell (nucleus, ribosomes, rough and smooth endoplasmic reticulum, mitochondria, centrioles, lysosomes, nucleolus)
- 2.3.2 Explain the role of the rough endoplasmic reticulum (rER) and the Golgi apparatus in protein trafficking within cells
- 2.3.3 Distinguish between the ultrastructures of eukaryotic and prokaryotic cells
- 2.3.4 Explain the role of DNA replication and mitosis in the cell cycle
- 2.3.5 Explain the significance of mitosis for growth and asexual reproduction
- 2.3.7 Explain how mammalian gametes are specialised for their functions including the acrosome reaction
- 2.3.9 Explain how meiosis results in the halving of chromosome numbers and the introduction of variation through random assortment (the stages of meiosis, crossing over chiasmata are not required)
- 2.3.10 Explain what is meant by stem cells, pluripotency and totipotency
- 2.3.11 Discuss the moral, ethical and spiritual implications of stem cell research

- 2.4.2 Recall the typical ultrastructure of animal cells and contrast this with the ultrastructure of typical plant cells (presence of cell wall), chloroplasts, amyloplasts (containing starch grains), vacuole, tonoplast, plasmodesmata, pits and middle lamellae
- 2.4.4 Describe the structure of sclerenchyma fibres and xylem vessels and where they are found in the plant stem. Describe how their physical properties enable them to be used for human benefit.

Theme 5: Reproduction

- 2.3.5 Explain the significance of mitosis for growth and asexual reproduction
- 2.3.7 Explain how mammalian gametes are specialised for their functions including the acrosome reaction
- 2.3.8 Explain the importance of fertilisation in sexual reproduction
- 2.3.9 Explain how meiosis results in the halving of chromosome numbers and the introduction of variation through random assortment (the stages of meiosis, crossing over chiasmata are not required)
- 2.4.10 Relate the structure of seeds to their role in the dispersal and survival of the plant (adaptations for dispersal, protection and nutrition of the embryo)

Theme 6: Genetics

- 1.2.13 Explain how errors in DNA replication can give rise to mutations and explain how CF results from one of a number of possible gene mutations
- 1.2.14 Explain the terms genotype, phenotype, recessive, dominant, homozygote and heterozygote and use a knowledge of genetics (including the interpretation of pedigree diagrams) to answer questions about monohybrid inheritance including CF, albinism, thalassaemia and garden pea height and seed morphology
- 1.2.15 Explain how the expression of the CF gene impairs the functioning of the gaseous exchange, digestive and reproductive systems
- 1.2.16 Describe the principles of gene therapy and distinguish between somatic and germ line therapy
- 2.3.14 Explain how certain characteristics may be affected by both genotype and the environment, including human height, skin colour, hair colour and cancers
- 2.3.15 Explain that cancers arise from uncontrolled cell division (detailed knowledge of the checkpoint control in the cell cycle is not required) and describe genetic, environmental and lifestyle causes of cancer
- 2.3.16 Discuss the principal outcomes of the Human Genome Project and the social, moral and ethical issues which arise from it
- 2.4.12 Explain how the genetic modification of plants is similar to but distinct from conventional breeding
- 2.4.13 Discuss the scientific arguments for and against the use of genetically engineered plants (improved plant quality, enhanced yield and consequences for the environment and health)

- 2.4.14 Discuss the social and ethical arguments for and against the use of genetically engineered plants.

Theme 7: Ecology and conservation

- 2.4.1 Explain the importance of water and inorganic ions (nitrate, calcium and magnesium) to plants
- 2.4.16 Recall the role of the carbon cycle in regulating atmospheric carbon dioxide levels and discuss the methods that can help to reduce atmospheric levels of carbon dioxide (including the use of biofuels and reforestation)
- 2.4.17 Discuss the possible relationship between CO₂ levels and global warming and how this can be investigated practically
- 2.4.18 Describe and analyse data from different types of evidence for and against global warming, including temperature records, pollen in peat bogs and dendrochronology and appreciate that scientific theories must be supported by evidence
- 2.4.19 Appreciate that data can be extrapolated to make predictions, that these are used in models of future climate change, and that these models have limitations
- 2.4.20 Explain how climate change (rising temperature, changing rainfall patterns and changes in seasonal cycles) can affect plants and animals (distribution of species, development and life cycles)
- 2.4.21 Explain the effect of increased temperature on the rate of enzyme activity.

Theme 8: Applications of Biology

- 1.2.15 Explain how the expression of the CF gene impairs the functioning of the gaseous exchange, digestive and reproductive systems
- 1.2.16 Describe the principles of gene therapy and distinguish between somatic and germ line therapy
- 1.2.17 Describe how gel electrophoresis can be used to separate DNA fragments of different length
- 1.2.18 Describe how the genetic profiles produced by gel electrophoresis can be used in genetic screening using gene probes
- 1.2.19 Explain the uses of genetic screening in the identification of carriers, prenatal testing (amniocentesis and chorionic villus sampling) and embryo testing
- 1.2.20 Discuss the social, ethical, moral and cultural issues related to genetic screening
- 2.4.4 Describe the structure of sclerenchyma fibres and xylem vessels and where they are found in the plant stem. Describe how their physical properties enable them to be used for human benefit
- 2.4.13 Discuss the scientific arguments for and against the use of genetically engineered plants (improved plant quality, enhanced yield and consequences for the environment and health)
- 2.4.14 Discuss the social and ethical arguments for and against the use of genetically engineered plants

- 2.4.18 Describe and analyse data from different types of evidence for and against global warming, including temperature records, pollen in peat bogs and dendrochronology and appreciate that scientific theories must be supported by evidence
- 2.4.19 Appreciate that data can be extrapolated to make predictions, that these are used in models of future climate change, and that these models have limitations.

Theme 9: Experimental and investigative skills

- 1.1.9 Analyse quantitative data on illness and mortality rates to determine health risks and recognise that it is important to distinguish between correlation and causation
- 1.1.11 Analyse data on energy budgets and diet so as to be able to discuss the consequences of energy imbalance
- 1.1.15 Calculate body mass indices (BMIs) using the formula $BMI = \text{body mass (kg)}/\text{height}^2$ (m) and explain their significance
- 1.1.17 Describe how the effect of caffeine on heart rate in *Daphnia* can be investigated practically
- 1.2.3 Describe how the effect of temperature on membrane structure can be investigated practically
- 1.2.11 Describe how enzyme concentrations and substrate concentrations can affect the rates of reactions and how the effect of enzyme concentration on reaction rate can be investigated practically
- 1.2.17 Describe how gel electrophoresis can be used to separate DNA fragments of different length
- 2.3.6 Describe the stages of mitosis and how they can be observed practically
- 2.3.13 Describe how the expression of a gene can be demonstrated practically by induction of β galactosidase
- 2.4.4 Describe the structure of sclerenchyma fibres and xylem vessels and where they are found in the plant stem. Describe how their physical properties enable them to be used for human benefit
- 2.4.7 Describe how to determine the strength of fibres
- 2.4.8 Compare how William Withering developed his digitalis soup with drug developing and testing nowadays
- 2.4.9 Describe how to investigate the antibacterial properties of plants
- 2.4.18 Describe and analyse data from different types of evidence for and against global warming, including temperature records, pollen in peat bogs and dendrochronology and appreciate that scientific theories must be supported by evidence
- 2.4.22 Describe how to investigate the effects of temperature on the development of organisms (eg plant growth or brine shrimp hatch rates)
- 2.4.23 Discuss the way in which scientific conclusions about controversial issues can sometimes depend on who is reaching the conclusions, including their ethical and cultural perspectives.

Presentation of the specification by themes - A2

The learning outcomes for the A2 specification are organised below according to biological theme. This presentation enables teachers to identify how the learning outcomes in the topics link together as themes. Each learning outcome retains the same identifying number. Some of the AS themes are continued into A2 whilst other themes are introduced into the A2. This can be seen in the mapping document on page 55 which shows the distribution of the 14 themes through the AS and A2 units.

Theme 6: Genetics (continued)

- 4.5.2 Explain what is meant by conservation of genetic diversity and explain how genetic diversity is generated through mutations and recombination of genes including independent assortment and crossing over
- 4.5.3 Explain the inheritance of characteristics controlled by alleles at two loci. Students should be able to construct and interpret genetic diagrams for dihybrid crosses (linkage is not required)
- 4.5.12 Describe how natural selection can lead to evolution through gene mutation and changes in allele frequencies
- 4.5.14 Explain how reproductive isolation can lead to speciation
- 5.8.16 Explain that some characteristics are controlled by alleles at many loci (polygenic inheritance) and how this can give rise to phenotypes which show continuous variation
- 5.8.17 Consider the methods used to compare the contributions of nature and nurture to brain development (including evidence from the abilities of new born babies, animal experiments, studies of individuals with damaged brain areas, twin studies and cross-cultural studies).

Theme 7: Ecology and conservation (continued)

- 4.5.1 Explain the principles of taxonomy and its significance in addressing the challenges faced by the scientific community in cataloguing biodiversity. Describe how keys are used for identification purposes. Students only need to know the features of the five kingdoms, but should appreciate that other classification systems exist (details of other taxonomic groups are not required).
- 4.5.4 Describe how to carry out a study on the ecology of a named terrestrial or semi-terrestrial habitat (including the use of quadrats and transects to assess abundance and distribution of organisms and the measurement of abiotic factors to include soil factors, temperature, humidity and aspect.)
- 4.5.5 Explain the distribution of organisms in the habitat named in terms of biotic and abiotic factors measured and considered
- 4.5.6 Discuss the adaptations of one species in each of the trophic levels in a habitat they have studied
- 4.5.10 Explain the relationship between gross primary productivity, net primary productivity and plant respiration

- 4.5.11 Carry out calculations to determine the efficiency of energy transfers between trophic levels
- 4.5.16 Describe the concept of succession to a climax community
- 4.5.17 Discuss the extent to which zoos can play a role in the conservation of endangered species (scientific research, captive breeding programmes, reintroduction programmes and education)
- 4.5.18 Discuss ways in which conflicts between wildlife and humans can be reconciled and the social and cultural issues involved
- 4.5.19 Discuss how cultural issues are reflected in the legislation which drives UK and international initiatives that use biological principles to manage conservation and development sustainably.

Theme 8: Applications of biology (continued)

- 4.5.15 Appreciate why, for cultural reasons, the theory of evolution has been so controversial for some people
- 4.6.1 Describe how forensic pathologists determine the time of death (extent of decomposition, forensic entomology, body temperature, degree of muscle contraction)
- 4.6.2 Describe how forensic pathologists determine the identity of a dead person (physical resemblance, DNA fingerprinting, dental records)
- 4.6.3 Interpret data on the typical stages of succession on dead bodies
- 4.6.18 Discuss how an ‘evolutionary race’ exists between pathogens and drug developers
- 5.7.14 Explain how medical technology, including the use of key-hole surgery and prostheses, is enabling those with injuries and disabilities to participate in sports
- 5.7.15 Discuss whether the use by athletes of performance-enhancing substances, including creatine, testosterone and erythropoetin, is morally and ethically acceptable
- 5.8.17 Consider the methods used to compare the contributions of nature and nurture to brain development (including evidence from the abilities of new-born babies, animal experiments, studies of individuals with damaged brain areas, twin studies and cross-cultural studies).

Theme 9: Experimental and investigative skills (continued)

- 4.5.4 Describe how to carry out a study on the ecology of a named terrestrial or semi-terrestrial habitat (including the use of quadrats and transects to assess abundance and distribution of organisms and the measurement of abiotic factors to include soil factors, temperature, humidity and aspect.)
- 4.5.6 Discuss the adaptations of one species in each of the trophic levels in a habitat they have studied
- 4.6.16 Describe how to investigate the effect of different antibiotics on bacteria
- 5.7.9 Describe how to investigate the effects of exercise on tidal volume and breathing rate (knowledge of spirometer will not be assumed)

- 5.8.10 Describe how to investigate visual perception in humans (pattern recognition, optical illusions eg the Müller-Lyer illusion).

Theme 10: Photosynthesis and respiration

- 4.5.7 Explain the light dependent reactions of photosynthesis in C3 plants including how light energy is trapped by exciting electrons in chlorophyll and the role of these electrons in generating ATP, reducing NADP and producing oxygen through photolysis
- 4.5.8 Explain the light-independent reactions in C3 plants as reduction of carbon dioxide using the products on the light-dependent reactions (fixing of carbon dioxide in the Calvin cycle the role of GP, GALP and RuBP). Describe the products as simple sugars which are used by plants, animals and other organisms in respiration and the synthesis of new biological molecules
- 5.7.4 Describe the roles of glycolysis in aerobic and anaerobic respiration, starting with phosphorylation of glucose and ending with pyruvate (names of other compounds are not required)
- 5.7.5 Describe the role of the Krebs cycle in the complete oxidation of glucose and formation of CO₂, ATP, reduced NAD and reduced FAD (names of other compounds are not required)
- 5.7.6 Describe the synthesis of ATP by oxidative phosphorylation associated with the electron transport chain in mitochondria including the role of chemiosmosis
- 5.7.7 Explain the fate of lactate after a period of anaerobic respiration in mammals.

Theme 11: Infection and immunity

- 4.6.5 Describe the course of tuberculosis (TB) as an instance of a bacterial infection and of Human Immunodeficiency Virus (HIV) as an instance of viral infection
- 4.6.6 Explain how infectious diseases, as exemplified by TB and HIV, have a sequence of symptoms which may result in death
- 4.6.7 Describe the non-specific responses of the body to infection (inflammation, lysozyme action, interferon, phagocytosis)
- 4.6.8 Explain the roles of antigens and antibodies in the body's immune response including the involvement of plasma cells, macrophages, antigen-presenting cells and major histocompatibility complexes
- 4.6.9 Distinguish between the roles of B cells (B memory and B effector cells) and T cells (T helper, T killer and T memory cells) in the body's immune response
- 4.6.11 Explain how an infectious disease, as exemplified by TB, can interfere with the body's negative feedback mechanisms for thermoregulation
- 4.6.12 Describe the major routes pathogens may take in entering the body and explain the role of barriers in protecting the body from infection (skin, stomach acid, gut and skin flora)
- 4.6.13 Explain how individuals may develop immunity (natural, artificial, active, passive)

- 4.6.14 Discuss how ‘the evolutionary race’ between pathogens and their hosts has resulted in sophisticated evasion mechanisms in Human Immunodeficiency Virus (HIV) and *Mycobacterium tuberculosis* (TB)
- 4.6.17 Explain why antibiotic resistance in bacteria is an increasing problem

Theme 12: Evolution

- 4.5.12 Describe how natural selection can lead to evolution through gene mutation and changes in allele frequencies
- 4.5.13 Discuss the historical development of the theory of evolution with reference to the work of Darwin, Wallace, Lamarck and Malthus
- 4.5.14 Explain how reproductive isolation can lead to speciation
- 4.5.15 Appreciate why, for cultural reasons, the theory of evolution has been so controversial for some people.

Theme 13: Exercise, anatomy and physiology

- 4.6.10 Explain the role of negative feedback in maintaining systems within narrow limits
- 5.7.1 Recall the way in which muscles, tendons, the skeleton and ligaments interact to enable movement including antagonistic muscle pairs, extensors and flexors
- 5.7.3 Explain how phosphorylation of ATP requires energy and how dephosphorylation of ATP provides an immediate supply of energy for biological processes
- 5.7.8 Explain how variations in ventilation and cardiac output enable efficient delivery of oxygen to tissues and removal of carbon dioxide from them, including how the heart rate and ventilation rate are controlled and the roles of the cardiovascular control centre and the ventilation centre
- 5.7.10 Discuss why some animals are better at short bursts of high intensity exercise while others are better at long periods of continuous activity
- 5.7.11 Describe the structural, and explain the physiological, differences between fast and slow twitch muscle fibres
- 5.7.12 Discuss the concept of homeostasis and its importance in maintaining the body in a state of dynamic equilibrium during exercise as exemplified by thermoregulation, including the role of the heat loss, heat gain centres and mechanisms for controlled body temperature
- 5.7.13 Discuss possible disadvantages of exercising too much (wear and tear on joints, suppression of the immune system) and exercising too little (increased risk of obesity, CHD and diabetes).

Theme 14: Nervous and hormonal control

- 5.8.3 Describe how a nerve impulse (action potential) is conducted along an axon including changes in membrane permeability to sodium and potassium ions and the role of the nodes of Ranvier

- 5.8.4 Describe the structure and function of synapses including the role of neurotransmitters (including acetylcholine)
- 5.8.5 Describe how the nervous systems of organisms can detect stimuli with reference to rods in the retina of mammals, the roles of rhodopsin, opsin, retinal, Na⁺ ions, cation channels and hyperpolarisation of rod cells in forming action potential in the optic nerve
- 5.8.6 Compare and contrast nervous and hormonal coordination (details of individual hormones are not required)
- 5.8.7 Locate and state the functions of the regions of the human brain's cerebral hemispheres (ability to see, think, learn and feel emotions), hypothalamus (thermoregulate), cerebellum (co-ordinate movement) and medulla oblongata (control the heartbeat)
- 5.8.8 Explain how images produced by MRI, fMRI and CT scans can be used to investigate brain structure and activity
- 5.8.9 Discuss the evidence that there exists a critical 'window' within which humans must be exposed to particular stimuli if they are to develop their visual capacities to the full
- 5.8.11 Describe ways in which animals including humans can learn (habituation, classical conditioning, operant conditioning and insightful learning)
- 5.8.12 Describe the role animal models have played in understanding human brain development and function (Pavlov's dogs, Hubel and Wiesel's experiments with monkeys and kittens)
- 5.8.13 Discuss the moral and ethical issues related to the use of animals in medical research
- 5.8.14 Explain how imbalances in certain, naturally occurring, brain chemicals (dopamine, serotonin) can contribute to adverse consequences for health (Parkinson's disease, depression) and to the development of new drugs
- 5.8.15 Explain the effects of drugs on synaptic transmissions with particular reference to ecstasy (MDMA) and the use of L-Dopa in the treatment of Parkinson's disease.

Mapping of themes in AS and A2 units

	Theme	AS	A2
1	Transport	✓	
2	Health	✓	
3	Biological Molecules	✓	
4	Cell Biology	✓	
5	Reproduction	✓	
6	Genetics	✓	✓
7	Ecology and Conservation	✓	✓
8	Applications of Biology	✓	✓
9	Experimental Investigative Skills	✓	✓
10	Photosynthesis and Respiration		✓
11	Infection and Immunity		✓
12	Evolution		✓
13	Exercise, Anatomy and Physiology		✓
14	Nervous and Hormonal Control		✓

Textbooks and other resources

Salters-Nuffield Advanced Biology course materials

Comprehensive support materials for students, teachers and technicians are being produced by the Salters-Nuffield Advanced Biology project team in the Science Curriculum Centre, University of York and The Nuffield Foundation, working with teachers, academics and industrialists.

All the Salters-Nuffield Advanced Biology course books are published by Heinemann Educational. Pilot books for the AS Units were published in 2002, and those for the A2 Units in 2003 will be revised and re-edited in the light of feedback from pilot centres for full publication in 2004/2005.

The books are listed below:

- *A2 Topics 1 & 2 Student Book*, summer 2003, ISBN: 0435628364
- *A2 Topics 3 & 4 Student Book*, winter 2003, ISBN: 0435628372.
- *AS Topics 1 & 2 Student Book*, summer 2002, ISBN: 0435628348
- *AS Topics 3, 4 & 5 Student Book*, summer 2002, ISBN: 0435628356

These books devote one chapter to each of the course topics. Each chapter includes:

- overview of the topic
- contextual material
- exposition of biology concepts and principles
- details of activities and assignments
- suggestions for further reading and investigation
- questions and problems.

Website and CD-Rom support

These include:

- online activities using modelling simulations and animations
- online self-tests for students
- customisable practical worksheets and notes
- online activities to develop and support related science, maths and ICT skills
- online discussion forum
- teacher and technician guidance and notes
- updates from the Salters-Nuffield team.

Website details

www.heinemann.co.uk/science

Texts

The post-pilot materials will consist of two student books (one for the AS course and one for the A2) and electronic support.

For details of publication dates and prices contact:

Heinemann Educational Publishers
Halley Court
Jordan Hill
Oxford
OX2 8EJ

Telephone: 01865 311366

Website: www.heinemann.co.uk

Order telephone number: 01865 888080

Order fax: 01865 314029

Order email: orders@heinemann.co.uk

Other texts

- *Biological Nomenclature – standard terms and expressions used in the teaching of biology*, (Third Edition, Institute of Biology, 2000) ISBN: 0900490365
- *Signs, Symbols and Systematics, The ASE companion to 16 – 19 science* (ASE, 2000) ISBN: 0863573126
- *Topics in Safety – Third Edition* (ASE, 2001) ISBN: 0863573169

Support and training

Support from the project team

The Salters-Nuffield Advanced Biology project team runs training courses for teachers and technicians from centres that are following, or preparing to follow, the Salters-Nuffield Advanced Biology course.

The project team also runs an advice service to help with questions concerning the teaching of the course.

For further information please contact the project secretary at:

Salters-Nuffield Advanced Biology Project
Science Curriculum Centre
University of York
Heslington
York
YO10 5DD

Telephone: 01904 432524
Fax: 01904 434078
Email: nn2@york.ac.uk

The Salters-Nuffield Advanced Biology website contains further information about the project and can be found at:

www.advancedbiology.org

Enquiries concerning assessment and administration should be addressed to the Assessment Leader for Biology at Edexcel. Issues relating to the specification should be addressed to the Qualification Leader for Biology at Edexcel.

Support from Edexcel

The following support materials will be available from Edexcel:

- specimen papers
- exemplar coursework.

Other materials will be available to centres during the lifetime of the specification in response to centres' needs.

Additional copies of specification support materials may be obtained from:

Edexcel Publications
Adamsway
Mansfield
Notts NG18 4FN

Telephone: 01623 467467
Fax: 01623 450481
Email: publications@linneydirect.com
Website: www.edexcel.org.uk

Examiner report and comments

A subject report will be issued to centres for the Edexcel AS and Advanced GCE in Biology (Salters-Nuffield) after each examination series. Additional copies may be obtained from Edexcel Publications (address on previous page).

Training

A programme of Professional Development and Training courses covering various aspects of the specification and examination will be arranged by Edexcel each year on a regional basis. Full details may be obtained from:

Professional Development and Training
Edexcel
One90 High Holborn
London
WC1V 7BH

Telephone: 0870 240 9800
Fax: 0207 404 0520
Email: trainingenquiries@edexcel.org.uk

Regional offices and enquiries

Further advice and guidance is available through our national network of regional offices. For details of your nearest office, please call Customer Services on 0870 240 9800.

Other useful contacts

Institute of Biology
Head of Education and Training
Institute of Biology
20 Queensberry Place
London SW7 2DZ

Telephone: 020 7581 8333
Website: www.iob.org
Email: info@iob.org

Wellcome Trust
183 Euston Road
London NW1 2BE

Telephone: 020 7611 8888
Website: www.wellcome.ac.uk
Email: contact@wellcome.ac.uk

National Centre for Biotechnology Education
University of Reading
Whiteknights
PO Box 226
Reading RG6 6AP

Telephone: 01189 973743
Website: www.ncbe.reading.ac.uk
Email: NCBE@reading.ac.uk

Grade descriptions for advanced level

The following grade descriptions indicate the level of attainment characteristic of the given grade at Advanced level. They give a general indication of the required learning outcomes at each specified grade. The descriptions should be interpreted in relation to the content outlined in the specification. They are not designed to define the content. The grade awarded will depend in practice upon the extent to which the student has met the assessment objectives overall. Shortcomings in some aspects of the examination may be balanced by better performances in others.

Grade A

Students recall and consistently use biological knowledge, facts, principles and concepts from the whole specification with few significant omissions, and show good understanding of the principles and concepts they use. They select biological knowledge relevant to most situations and present their ideas clearly and logically, making use of appropriate biological terminology, particularly when referring to specific technical terms and in expressing more general concepts and ideas.

Students accurately carry out a range of calculations in a logical manner with little guidance and, where appropriate, support their solutions by logical explanation. They demonstrate a good understanding of principles and apply them in both familiar and new contexts. They show insight into problems and suggest a number of possible solutions, using techniques, arguments or knowledge and understanding from more than one area of the specification and other areas of their experience. Most responses are correct, relevant and logical. In particular, longer questions are answered to an appropriate depth, and ideas are communicated effectively with coherent and detailed explanations.

In experimental activities, students independently formulate a clear and accurate plan. They use a range of manipulative techniques safely and skilfully, making and recording observations with appropriate precision. They interpret and describe the trends and patterns shown by data presented in tabular or graphical form, indicating, where appropriate, anomalies and inconsistencies. They provide coherent, logical and comprehensive explanations using appropriate biological knowledge and terminology. They comment critically on data, evaluate it and use it to support or reject various hypotheses. They present clearly and concisely both sides of an argument by weighing up the evidence.

Grade C

Students recall and show a sound use of biological knowledge, facts, principles and concepts from many parts of the specification and show understanding of some fundamental principles and concepts. They frequently select biological knowledge relevant to a particular situation or context and present their ideas clearly and logically, making use of appropriate biological terminology.

Students carry out a range of calculations, making progress with minimal guidance. They show knowledge of fundamental principles and are often able to apply these in new contexts. They bring together information from more than one area of the specification. Many responses are correct, relevant and logical.

In experimental activities, students formulate a plan which may need some modification. They use a range of techniques safely, making and recording observations and measurements which are adequate for the task. They interpret and explain experimental results, relating these to biological knowledge and understanding and, with help, evaluate their results. They comment on data and use selected data to support a particular hypothesis. They make choices in statistical sampling.

Grade E

Students recall and use biological knowledge, facts, principles and concepts from some parts of the specification and demonstrate some understanding of fundamental principles and concepts beyond that expected of sound GCSE students.

Students select discrete items of knowledge in response to structured questions and use basic biological terminology. This may be displayed consistently across the questions set or may vary between being quite good and poor on different questions.

Students select appropriate facts and principles to solve problems concerning familiar material. Where problems are concerned with unfamiliar material, answers relate to the appropriate subject area, even if difficulties are experienced in applying the facts and principles involved.

With some guidance, students accurately carry out straightforward calculations involving the rules of number, such as calculations of percentages, making clear the steps in the calculation. They apply knowledge and biological principles contained within the specification to material presented in a familiar or closely related context.

They make connections between some ideas encountered in different parts of the specification. Their answers show some logic and coherence, although they may include irrelevant material. They use correctly a limited range of biological terminology.

In experimental activities, students formulate some elements of a practical approach when provided with guidance. They carry out frequently encountered practical procedures in a reasonably skilful manner, recognising the risks in familiar procedures and obtaining some appropriate results. They interpret broad trends shown by data presented in tabular or graphical form. They select appropriate facts and principles to produce limited but relevant explanations and make superficial conclusions from data. They may need assistance to relate these to biological knowledge and understanding.

Appendices

Appendix 1: Glossary of terms used in the specification and in the written tests

- **Advantages, disadvantages**

Here there will be two (or more) sets of data, structures, functions, processes or events to be referred to and the answer must relate to both. One process, or whatever, is required to be compared with another. It is important that the answers are comparative and that the feature being referred to is clearly stated.

- **Analyse and interpret**

Identify, with reasons, the essential features of the information or data given. This may involve some manipulation of the data.

- **Appreciate**

Show an awareness of the significance of, but without detailed knowledge of, the underlying principles.

- **Compare, contrast, distinguish between, differs from**

As with advantages and disadvantages, here there will be two (or more) sets of data, structures, functions, processes or events to be referred to and the answer must relate to both. It is important to select equivalent points and keep them together.

Compare generally indicates that similarities as well as differences are expected; *contrast*, *distinguish between* or *differs from* indicate that the focus should be on the differences.

- **Demonstrate**

Show the effects, probably through practical experiment.

- **Describe**

This may be related to a biological event or process, or to data presented in a table, graph or other form. The description must be concise and straightforward, using relevant biological terms rather than vague generalisations. The trend should be presented in words or translated into another form. If interpreting numerical data, it is often appropriate to refer to the figures, and these should be ‘manipulated’ in some way, for instance the trend could be quantified or the percentage difference over a period of time calculated.

- **Discuss**

Give a considered account of a particular topic about which a degree of uncertainty exists.

- **Distinguish**

Identify appropriate differences in a given context.

- **Explain, give explanations, give reasons**

The answer would be expected to draw on biological knowledge to give reasons or explanations for the information or data given. Usually 2- or 3-mark answers are required and the answer should go beyond just repetition or reorganisation of the information or data presented. Students should check that their response answers the question, ‘Why ...?’.

- **Make a link**
Point out the connection between separate points.
- **Name, state, give**
Indicate that short, factual answers are needed, possibly with precise use of biological terms or the name of a structure. Often one-word answers are sufficient.
- **Recall**
Present knowledge gained at Key Stage 4 through the study of the National Curriculum science programme and through the study of units in this specification.
- **Review**
Make a general survey of an extensive topic.
- **Suggest/suggestion**
Implies that the answer may include material or ideas which have not been learnt directly from the specification. A reasonable suggestion, using biological knowledge and understanding of related topics, is required.
- **Summarise**
Give a concise account of the main points.
- **Understand**
Explain the underlying principles and apply the knowledge to novel situations.
- **Using the information in the diagram/on the graph/in the table/features visible in the diagram**
Refer only to the information presented in the question and not other examples or features, which may be perfectly correct but are not shown and are, therefore, not what the examiners require.

Appendix 2: Key skills mapping - summary table

The AS and Advanced GCE Biology (Salters-Nuffield) qualification offers a range of opportunities for students to:

- develop their key skills
- generate evidence for their portfolios.

In particular, the following key skills can be developed through this specification at Level 3:

- communication
- information technology
- application of number
- working with others
- improving own learning and performance
- problem solving.

Additionally, students working towards the Key Skills Qualification will also need to undertake the external tests associated with communication, application of number and information technology. These may be taken as stand-alone tests or as part of the Edexcel General Studies GCE Advanced.

Examples are highlighted in *Appendix 3*, and further opportunities to gain skills will arise in the teaching of all units as indicated below.

Key Skills (Level 3)	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
Communication						
C3.1a	✓	✓	✓	✓	✓	✓
C3.1b	✓	✓	✓	✓	✓	✓
C3.2	✓	✓	✓	✓	✓	✓
C3.3	✓	✓	✓	✓	✓	✓

Appendix 3: Key skills development suggestions

Each unit within the AS and Advanced GCE Biology (Salters-Nuffield) will provide opportunities for the development of all six of the key skills identified. This appendix identifies the key skills evidence requirements and also provides a detailed mapping of those opportunities. Below, for each skill, are illustrative activities, which will aid key skill development and facilitate the generation of appropriate portfolio evidence.

Communication - level 3

For the communication key skill, students are required to hold discussions and give presentations, read and synthesise information and write documents. Students will be able to develop all of these skills through an appropriate teaching and learning programme based on this Advanced GCE.

Key skill portfolio evidence requirement	AS/A2 Units	Opportunities for development or internal assessment
<p>C3.1a Contribute to a group discussion about a complex subject.</p>	<p>1, 2, 3, 4, 6, 7</p>	<p>Many of the topics in the Biology (Salters-Nuffield) specification lend themselves to forming the basis of a group discussion. Complex subjects can be based on a number of ideas, some of which may be conceptual and very detailed. Often, discussions of practical work will lead to the development of theory. Specialist vocabulary may be used in the discussion. During the discussion students should make clear any relevant contributions, and develop points and ideas whilst listening and responding sensitively to others. They should also create opportunities for others to contribute as appropriate.</p> <p>Relevant subjects for discussion include:</p> <ul style="list-style-type: none"> • The perception of risk – Topic 1 • The impact of lifestyle choices on health – Topic 1 • The ethical and social issues in the use of genetic testing – Topic 2 • The ethical and social issues in the use of stem cells for medical research – Topic 3 • The impact of the findings of the Human Genome Project – Topic 3 • Is climate change really happening? – Topic 4 • Can plants provide a more sustainable future? – Topic 4 • Can zoos help endangered animals survive? – Topic 5 • Applications of gene technology – Topics 2, 3, and 5 • Is the use of performance enhancing substances in sport ethically acceptable? – Topic 7.

Key skill portfolio evidence requirement	AS/A2 Units	Opportunities for development or internal assessment
<p>C3.1b Make a presentation about a complex subject, using at least one image to illustrate complex points.</p>	<p>1, 2, 3, 4, 5, 6, 7</p>	<p>Following a period of research, students could be given the opportunity to present their findings to the rest of the group. For example, students could present their key findings and conclusions resulting from their coursework project.</p> <p>During the presentation students should speak clearly and use a language and style, which are appropriate to their audience and the subject. The presentation should have a logical structure, which allows the audience to follow the sequence of information and ideas. The presentation should include an appropriate range of techniques such as:</p> <ul style="list-style-type: none"> • the use of examples to illustrate complex points • audience experience used to involve the audience • tone of voice varied, etc. <p>Where appropriate, images should be used both to illustrate points and help engage the audience. Images could include charts, molecular models, graphs and diagrams of apparatus and processes and pictures. At least one image should be used to illustrate and help convey a complex point.</p> <p>Subject areas which could form the basis of a presentation include:</p> <ul style="list-style-type: none"> • The unbalanced diet and the promotion of healthy eating – Topic 1 • Stem cell research – Topic 3 • The Human Genome Project – Topic 3 • Uses of plant materials to aid sustainable development – Topic 4 • The changing role of zoos in conservation – Topic 5 • DNA technologies – Topics 2, 3 and 5 • How medical technologies can enable those with injuries and disabilities to participate in sport – Topic 7.

Key skill portfolio evidence requirement	AS/A2 Units	Opportunities for development or internal assessment
<p>C3.2 Read and synthesise information from two extended documents about a complex subject.</p> <p>One of these documents should include one image.</p>	<p>1, 4, 5, 6, 8</p>	<p>Extended documents may include textbooks, reports and articles of more than three pages. At least one of these documents should contain an image from which students can draw appropriate and relevant information.</p> <p>Students will need to select and read material that contains relevant information. From this information they will need to identify accurately (and compare) the lines of reasoning and main points from the text and images. Students will then need to synthesise this information into a relevant form eg for a presentation, discussion, summary or an essay.</p> <p>The completion of the AS coursework visit or issue report will require students to undertake preliminary research. Preparation for the discussion and presentation of a complex subject would also involve research.</p> <p>The subject matter could include the following:</p> <ul style="list-style-type: none"> ● background reading on cardiovascular disorders in order to find relevant information to present in a handout for members of a local community group – Topic 1 ● global warming – Topic 4 ● ecological study (background research) – Topic 5 ● use of animals in medical research – Topic 8.

Key skill portfolio evidence requirement	AS/A2 Units	Opportunities for development or internal assessment
<p>C3.3 Write two different types of documents about complex subjects.</p> <p>One piece of writing should be an extended document and include at least one image.</p>	<p>2, 3, 4, 5</p>	<p>Students are required to produce two different types of document. At least one of these should be an extended document, for example a report or an essay of more than three pages.</p> <p>The document should have a form and style of writing which is fit both for its purpose and the complex subject matter covered. At least one of the documents should include an appropriate image which contains and effectively conveys relevant information. Specialist vocabulary should be used where appropriate and the information in the document should be clearly and coherently organised eg through the use of headings, paragraphs.</p> <p>Students should ensure that the text is legible and that spelling, punctuation and grammar are accurate.</p> <p>Some suitable documents might be the:</p> <ul style="list-style-type: none"> • issue report for AS coursework • individual project report for A2 coursework • practical investigation report eg on the effect of caffeine on the heart rate of Daphnia or the immobilisation of lactase – Topic 1 • leaflet on dietary fats and CVD – Topic 1 • newspaper report on global warming – Topic 4.

Evidence

Student evidence for communication could include:

- tutor observation records
- preparatory notes
- audio/video tapes
- notes based on documents read
- essays
- reports on practical work, investigations or work experience.

Information technology - level 3

When producing work for Edexcel AS and Advanced GCE in Biology (Salters-Nuffield), students will have numerous opportunities to use relevant information technology. The internet, CD-Roms, etc could be used to collect information. Documents can be produced using relevant software and images may be incorporated in those documents. Early drafts of documents could be emailed to teachers for initial comments and feedback.

For this key skill students are required to carry out at least one ‘substantial activity’. This is defined as ‘an activity that includes a number of related tasks, where the results of one task will affect the carrying out of others’. The activity should allow students to generate evidence for all three areas of evidence required in Part B of the IT unit. If students undertake coursework as part of their Edexcel AS/A2 in Biology (Salters-Nuffield) use information technology, they will have opportunities to generate evidence for all three sections identified as part of a ‘substantial activity’.

In addition, students will be able to use information technology to generate evidence for the communication key skill. For example, the extended document with images, required for C3.3, could be generated using appropriate software.

Key skill portfolio evidence requirement	AS/A2 Units	Opportunities for development or internal assessment
<p>IT3.1 Plan and use different sources to search for, and select, information required for two different purposes.</p>	<p>1, 3, 4, 5</p>	<p>Students will need to plan, and document, how they are to use IT as part of an activity, including how they will search for and incorporate relevant information from different electronic sources. These may include the internet and CD-Roms. Information selected must be relevant and of the appropriate quality.</p> <p>Information could be selected on subject areas including:</p> <ul style="list-style-type: none"> • background information on the incidence of CVD over time – Topic 1 • outcomes of the Human Genome Project – Topic 3 • use of data logging equipment in experiments to investigate the effect of carbon dioxide on atmospheric temperature – Topic 4 • role of zoos in conservation – Topic 5 • use of data from remote data logging to investigate the effects of exercise on physiological parameters – Topic 7.

Key skill portfolio evidence requirement	AS/A2 Units	Opportunities for development or internal assessment
<p>IT3.2 Explore, develop, and exchange information and derive new information to meet two different purposes.</p>	<p>1, 2, 3, 4, 6</p>	<p>Students are required to bring together (in a consistent format) their selected information and use automated routines as appropriate, for example using icons and macros to generate standard forms of lists, tables, images.</p> <p>Students should sort and group the information generated, and produce graphs and charts if appropriate, to allow them to draw conclusions. For example, students could be working towards giving a presentation based on their findings. Information could be presented in handouts and/or as part of an automated slide show. Initial drafts could be emailed to their tutor for feedback, or could be stored on a shared drive for access by others.</p> <p>Biology provides many opportunities to work with, explore, develop, and exchange information. There are also many times when the use of a spreadsheet can deliver new information for a variety of purposes.</p> <p>Suitable areas include:</p> <ul style="list-style-type: none"> • presentation of quantitative data from experimental investigations eg how enzyme concentration affects rate of reaction – Topic 2 • slide show to explain transport in flowering plants – Topic 4 • data logging in biological investigations such as monitoring changes in tree trunk width over a 24 hour period – Topic 4 • development of a way of quantifying the effects of antibiotics and bacterial growth – Topic 6.

Key skill portfolio evidence requirement	AS/A2 Units	Opportunities for development or internal assessment
<p>IT3.3 Present information from different sources for two different purposes and audiences.</p> <p>Your work must include at least one example of text, one example of images and one example of numbers.</p>	4, 5	<p>In presenting information, students will need to develop a structure which may involve the modification of templates, the application of page numbers, dates, etc. Tutors may provide early feedback on layout, content and style, which will result in formatting changes (early drafts should be kept as portfolio evidence).</p> <p>The final format should be suitable for its purpose and audience, eg OHTs/handouts for a presentation, AS experiment. The document should have accurate spelling (use of spellchecker) and have been proof read.</p> <p>There are many opportunities for presenting information during the Biology (Salters-Nuffield) course. Text, images and numbers can often be used. Presentations can be made to teaching groups, to the teacher as a result of a personal study, or to other scientists.</p> <p>Suitable opportunities include:</p> <ul style="list-style-type: none"> • individual study and investigation reports; presentation of findings to fellow students via an automated slide show and a handout of the key findings, as identified in earlier sections • diet: understanding energy needs; preparing a slide show for the local weight watchers group • sustainable development in the workplace; preparation of a talk and report for the centre senior management team.

Evidence

Student evidence for information technology could include:

- tutor observation records
- preparatory plans
- printouts with annotations
- draft documents.

Application of Number - level 3

The Edexcel AS and Advanced GCE in Biology (Salters-Nuffield) provides opportunities for students both to develop the key skill of application of number and to generate evidence for their portfolios. As well as undertaking tasks related to the three areas of evidence needed, students are also required to undertake a substantial and complex activity. This will involve students in obtaining and interpreting information, and using this information when carrying out calculations and explaining how the results of the calculations meet the purpose of the activity.

Key skill portfolio evidence requirement	AS/A2 Units	Opportunities for development or internal assessment
<p>N3.1 Plan and interpret information from two different types of sources, including a large data set.</p>	<p>1, 2, 4, 5</p>	<p>Students are required to plan how to obtain and use the information required. They should obtain relevant information (which may be from a large data set of over 50 items) using appropriate methods.</p> <p>Many of the topics in the Biology (Salters-Nuffield) course provide opportunities for planning and interpreting information. Books, CD-Roms and the internet contain a wealth of data, including some in large sets. Experiments can be performed to obtain data, on which calculations are made and their results interpreted. There are a number of investigations in the course where students need to plan how to obtain measurements, obtain the information, choose appropriate methods, and justify their procedures.</p> <p>Suitable activities include:</p> <ul style="list-style-type: none"> • internet search (eg using www.statistics.gov.uk) and interpretation of information on illness and mortality rates – Topic 1 • laboratory investigations: replication trials to increase the validity of the results, eg on enzyme activity – Topic 2 • interpretation of climate change data – Topic 4 • ecological investigation – Topic 5.

Key skill portfolio evidence requirement	AS/A2 Units	Opportunities for development or internal assessment
<p>N3.2 Carry out multistage calculations to do with:</p> <ul style="list-style-type: none"> a amounts and sizes b scales and proportion c handling statistics d rearranging and using formulae. <p>Students should work with a large data set on at least one occasion.</p>	<p>1, 2, 3, 5</p>	<p>Students must carry out their calculations and show their methods of working. They must show how they have checked results and corrected their work as necessary.</p> <p>Multistage calculations are a feature of biology and occur in many topics. Amounts in biology are introduced in the first topic in Unit 1 and permeate the whole course. Calculations involving proportions are at the heart of most amount calculations. Many of these can most easily be solved by changing the subject of formulae. Not only is it necessary to check methods and results for errors but, in certain experiments, random errors can be treated fully.</p> <p>Suitable topics include:</p> <ul style="list-style-type: none"> • calculation of risk – Topic 1 • estimating the consequences of alveoli on surface area of the lungs – Topic 2 • dilution of solutions in carrying out experimental procedures, such as series of protease solutions – Topic 2 • use of a graticule with a light microscope – Topic 3 • investigating the size of cell organelles – Topic 3 • use of suitable statistical tests in the individual project and appropriate laboratory investigations eg ecological investigation – Topic 5.

Key skill portfolio evidence requirement	AS/A2 Units	Opportunities for development or internal assessment
<p>N3.3 Interpret results of calculations, present findings and justify methods. Students must use at least one graph, one chart and one diagram.</p>	<p>1, 2, 4</p>	<p>Based on their findings, students must select suitable methods of presentation, using appropriate charts, diagrams and tables. They should draw relevant conclusions from their findings. Students should indicate why they have chosen a particular approach, identify possible sources of error in their work and show how this work relates to the purpose of the activity undertaken.</p> <p>Quantitative data collection from investigations produces results which need careful interpretation. Results may be presented in a variety of ways, including graphs, charts and diagrams. Students are always expected to show their reasoning clearly and to make informed comments on the results of their calculations.</p> <p>Suitable subjects include:</p> <ul style="list-style-type: none"> ● investigating the effect of caffeine on heart rate of Daphnia – Topic 1 ● investigating the effect of enzyme concentration on the rate of reaction – Topic 2 ● investigating the strength of plant fibres – Topic 4 ● individual coursework projects in A2.

Working with others - level 3

To achieve this key skill, students are required to carry out at least two complex activities. Students will negotiate the overall objective of the activity with others and plan a course of action. Initially, the component tasks of the activity, and their relationships, may not be immediately clear.

During the activity the student must work in both group-based and one-to-one situations.

Key skill portfolio evidence requirement	AS/A2 Units	Opportunities for development or internal assessment
<p>WO3.1 Plan the activity with others, agreeing objectives, responsibilities and working arrangements.</p>	<p>2, 3, 4, 8</p>	<p>Students working in groups of 5 to 6 are required to investigate, for example, cell ultra-structure or the effects of CF. The group could agree to share the required tasks in an attempt to obtain information that could be displayed in poster format.</p> <p>Initial work requires identification of, and the agreeing of, objectives and planning how to meet them, including necessary action and resources. The group needs to agree responsibilities and working arrangements.</p> <p>Students working in groups of 3 to 4 could investigate the following:</p> <ul style="list-style-type: none"> • antibacterial properties of plants – Topic 4 • inheritance of mental disorders – Topic 8.
<p>WO3.2 Work towards achieving the agreed objectives, seeking to establish and maintain cooperative working relationships in meeting your responsibilities.</p>	<p>2, 3, 4</p>	<p>When working towards agreed objectives, students could work in pairs with each pair taking a specific task.</p> <p>The pair of students could plan how to divide up the task. For example, each student could take one of the ultra-structures identified, one organ system affected by CF or one of the plants under trial. They could then work as a team during the actual activity, for instance, while one student is making aseptic agar plates the other could be preparing the plant extracts.</p> <p>Students will need to plan effectively and organise their work so that they meet agreed deadlines and maintain appropriate working relationships.</p>

Key skill portfolio evidence requirement	AS/A2 Units	Opportunities for development or internal assessment
<p>WO3.3 Review the activity with others against the agreed objectives and agree ways of enhancing collaborative work.</p>	<p>2, 3, 4</p>	<p>Once the work is completed, the full group or the pair review outcomes against the agreed objectives. They should identify factors that have influenced the outcome and agree on ways in which the activity could have been carried out more effectively.</p> <p>The students could compare their quantitative results against those gained by other groups or pairs. An evaluation, perhaps including a treatment of errors, should identify areas of the exercise that could be improved. Students should suggest ways in which the group or pair could have worked differently and perhaps more effectively.</p> <p>The evaluation of the projects may use self-evaluation or the assessment of an independent reviewer.</p>

Opportunities were identified in communication 3.1 and students may use some of the suggestions to work on group presentations.

Evidence

Student evidence for working with others could include:

- tutor observation records
- preparatory plans
- records of process and progress made
- evaluative reports.

Improving own learning and performance - level 3

Within the Edexcel AS and Advanced GCE in Biology (Salters-Nuffield) course, students will have opportunities to develop and generate evidence that meets the evidence requirement of this key skill.

To achieve this key skill students will need to carry out **two** examples of study-based learning and **two** examples of activity-based learning. An example of study-based learning could be a student's preparation for a unit test. An example of activity-based learning could be taken from a student's programme of practical work. Students will also need to carry out **one** example of using learning from at least **two** different tasks to meet the demands of a new situation.

One of each of the examples of study-based learning and of the activity-based learning must contain at least **one** complex task. Two of these examples must include a period of self-directed learning. Over the period of the task students should seek and receive feedback, from tutors and others, on their target setting and performance.

Any substantial project work, including coursework, would be a suitable study-based learning activity and may be used to generate evidence for this key skill.

Key skill portfolio evidence requirement	AS/A2 Units	Opportunities for development or internal assessment
<p>LP3.1 Agree targets and plan how these will be met, using support from appropriate others.</p>	<p>1, 2, 3, 4, 5, 6, 7, 8</p>	<p>Students could draw up a plan to show how they intend to cover the assignments, tests and practice examination papers in their preparation for a unit test. They will set realistic dates and targets in consultation with their tutor. They will identify potential problems and suggest alternative courses of action. This approach may be particularly appropriate for students preparing to retake a unit test for which there is no formal teaching programme.</p> <p>Students will discuss with their teacher a limited number of practical skills, such as the use of the microscope when making biological drawings. They will agree a course of action on monitoring progress. Other suitable areas for assessment to identify would be essay, writing skills and the presentation and evaluation of results from practical investigations.</p>
<p>LP3.2 Use the plan, seeking feedback and support from relevant sources to help meet the targets, and use different ways of learning to meet new demands.</p>	<p>1, 2, 3, 4, 5, 6, 7, 8</p>	<p>Students will use their plan to meet targets and work effectively which may include prioritising tasks, managing time effectively and amending the plan as necessary. Students will seek and use feedback from tutors to help them improve their learning and performance. This may entail repeating a task or attempting a closely related one. Students may need to use different approaches to learning, including the use of IT-based tutorial material, the sharing of tasks with other students or making use of learning resource centres.</p> <p>The agreed plan would include strategies to improve performance and these would need to be implemented against an agreed timescale. The plan would allow for interim feedback from the teacher following self-assessment of progress made by the student.</p>

Key skill portfolio evidence requirement	AS/A2 Units	Opportunities for development or internal assessment
<p>LP3.3 Review progress, establishing evidence of achievements, and agree action for improving performance.</p>	<p>1, 2, 3, 4, 5, 6, 7, 8</p>	<p>Students should review their own progress and the quality of their learning and performance. They should be aware of the likely outcome if they are failing to meet targets or to make progress and, may need to take remedial action and seek help in an attempt to improve their performance. This may require an action plan to be drawn up and implemented.</p> <p>Students would undertake further implementation of the action plan and then undertake a reviewing process with their teacher against agreed criteria.</p>

Evidence

Student evidence for improving their own learning and performance could include:

- tutor records
- annotated action plans
- records of discussions
- learning log
- work produced.

Problem solving - level 3

To achieve this key skill students must apply their problem solving skills to complex activities. They need to show that they can recognise, explore and describe problems. They will have to generate and compare different ways of solving problems, then plan and implement their options. Finally, students must show that they can agree and apply methods for checking that problems have been solved and review their approaches to tackling problems. Each task must be applied for each of two problems.

Students taking this qualification should have a number of opportunities in their course to demonstrate their problem solving skills. In particular, practical exercises could be set which allow students to improve and demonstrate them.

Key skill portfolio evidence requirement	AS/A2 Units	Opportunities for development or internal assessment
<p>PS3.1 Recognise, explore and describe the problem, and agree the standards for its solution.</p>	<p>4, 5</p>	<p>As part of their programme of practical work, students could be given the problem of analysing, either quantitatively or qualitatively, an ‘unknown’ substance containing a number of components. Students could work alone or in teams to suggest different ways of solving the problem. They would recognise that it is complex and that no simple solution of identifying the substance is possible. They would select and use appropriate biochemical methods for exploring the problem and describe its main features. Students would have to agree the standards to be met to show the substance has been analysed to the required degree of accuracy.</p> <p>Possible problems for group activities have been identified earlier in the section on communication. Other areas may involve:</p> <ul style="list-style-type: none"> ● investigating the antibacterial properties of plants – Topic 4 ● ecological investigations such as zonation on a rocky seashore – Topic 5.
<p>PS3.2 Generate and compare at least two options which could be used to solve the problem, and justify the option for taking forward.</p>	<p>4, 5</p>	<p>Students would be expected to generate at least two options for tackling the problem. They would compare the main features of each option including materials and apparatus requirements, timescales to carry out the analysis and health and safety factors. Students would select the option which has the most realistic chance of success and justify their choice.</p> <p>In the plant antibacterial properties investigation, students will need to consider the different ways of making plant extracts for testing.</p> <p>In the ecological investigation, students would need to identify two species to record across the seashore.</p>

Key skill portfolio evidence requirement	AS/A2 Units	Opportunities for development or internal assessment
PS3.3 Plan and implement at least one option for solving the problem, and review progress towards its solution.	4, 5	For a laboratory-based problem, students would have to draw up detailed plans for quantities and apparatus. They could carry out a risk assessment before obtaining permission to go ahead with their experiments. Students would carry out their plan, using support and feedback from others, including their tutor. Progress would be reviewed. The plan may have to be revised as the investigations progress and careful consideration made of the risk assessment.
PS3.4 Agree and apply methods to check whether the problem has been solved, describe the results and review the approach taken.	4, 5	On completion of the investigations, results would be monitored by the tutor to check whether the expected standards had been met. Results would be described, perhaps in a report. Finally, the whole approach to solving the problem would be reviewed. A consideration would be given as to whether alternative methods might have proved more effective, based on the earlier problems identified.

Evidence

Student evidence for problem solving could include:

- description of the problem
- tutor observation records and agreement of standards and approaches
- annotated action plan
- reports on practical work
- records of discussions
- records of reviews.

Appendix 4: Sample student authentication sheets

GCE Advanced Subsidiary Examination 6133 UNIT 3

AUTHENTICATION CERTIFICATE

Examination date:

Please complete this form in BLOCK CAPITAL letters. It should then be attached to the front of the folder containing your work, or fixed to a blank sheet of paper at the front of your work if no folder is used.

Centre name:	Centre number:
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Student name:	Student number:
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AUTHENTICATION STATEMENT:

I declare that I have produced the work involved without external assistance apart from any which is acceptable under the scheme of assessment and is recorded.

Signed by.....

Date.....



GCE Advanced Subsidiary Examination

6135 UNIT 5

AUTHENTICATION CERTIFICATE

Examination date:

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Centre name:	Centre number:
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Student name:	Student number:
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AUTHENTICATION STATEMENT:

I declare that I have produced the work involved without external assistance apart from any which is acceptable under the scheme of assessment and is recorded.

Signed by.....

Date.....

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