

# Specification

## GCE Biology

Pearson Edexcel Level 3 Advanced Subsidiary GCE in Biology  
(8BI01)  
First examination 2014

Pearson Edexcel Level 3 Advanced GCE in Biology (9BI01)  
First examination 2014

Issue 5



## Edexcel GCE in Biology – Foreword

Edexcel is delighted that this specification has been developed in collaboration with the Salters-Nuffield Advanced Biology project, which leads the field in innovative approaches to teaching and learning in biology at A level.

Salters-Nuffield Advanced Biology is a collaboration between two major forces for innovation in science education: the University of York Science Education Group and the Nuffield Foundation. Both have a long and distinguished history of seminal curriculum projects in science and have combined their experience to develop a biology course which meets the needs of today's students.

The Salters-Nuffield project has extensively piloted its new approach over a number of years. Many key elements of this approach, such as studying the contemporary social and ethical context of the biological sciences, are now part of the How Science Works strand required in all A level Science specifications. Edexcel GCE in biology has benefited enormously from the expertise built up by the Salters-Nuffield project in incorporating effectively this important new aspect of A level biology in this specification.

The Salters-Nuffield project supports students and teachers with INSET and resources in addition to the support offered by the Edexcel team. The project retains the contemporary topicality of the course by a website which is kept up to date with news of new discoveries, applications and controversies for use by teachers and students. This enables students and teachers to not only adopt a course which is innovative in all respects but also fully up to date and always forward looking.

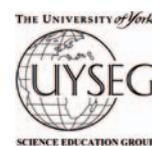
Edexcel



Nuffield Foundation



University of York





# About this specification

The Edexcel GCE in Biology is designed for use in schools and colleges. It is a part of a suite of GCE qualifications offered by Edexcel.

## Flexible and inspiring

The Edexcel GCE Biology specification has been designed to engage and inspire students by showing how an understanding of many contemporary issues requires a grasp of fundamental biological ideas.

It offers centres a choice of **two** well-proven teaching and learning styles within **one** common assessment structure.

The two approaches to the content of the specification are:

- a concept-led approach. This approach begins with a study of the laws, theories and models of biology and finishes with an exploration of their practical applications
- a context-led topic approach. This approach begins with the consideration of an application that draws on many different areas of biology, and then moves on to the biological concepts underlying this application.

The design of this approach is based on the Salters-Nuffield Advanced Biology Project.

Both approaches enable the use of motivating, up-to-date, contemporary contexts. Centres may offer courses based completely on either or both approaches, or 'mix and match' the approaches to different topics within one course. This aims both to attract and retain more students by matching their own learning needs and to make teaching more enjoyable for teachers.

## Manageable and well supported

This specification has a realistic, manageable level of content and assessment. One unit in each of AS and A2 is an internally assessed practical unit and extensive support for the practical assessment is available.

Both teaching approaches are well resourced with customised published materials including course texts and online support. In addition, the Salters-Nuffield Advanced Biology project team at the University of York organises courses for teachers and technicians who support this specification, and also provides an advice service to help with questions concerning the teaching of the course.

## Supporting you

Edexcel aims to provide the most comprehensive support for our qualifications. We have therefore published our own dedicated suite of resources for teachers and students written by qualification experts. We also endorse a wide range of materials from other publishers to give you a choice of approach.

For more information on our wide range of support and services for this GCE in Biology qualification, visit our GCE website: [www.edexcel.com/gce2008](http://www.edexcel.com/gce2008)

## Specification updates

This specification is Issue 5 and is valid for examination from Summer 2014. If there are any significant changes to the specification Edexcel will write to centres to let them know. Changes will also be posted on our website.

For more information please visit [www.edexcel.com](http://www.edexcel.com) or [www.edexcel.com/gce2008](http://www.edexcel.com/gce2008)

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# A Specification at a glance

## AS Unit 1: Lifestyle, Transport, Genes and Health

\*Unit code 6BI01

- Externally assessed
- Availability: June

**40%  
of the  
total AS  
marks**

**20% of  
the total  
GCE  
marks**

### Content summary:

- structure and function of carbohydrates, lipids and proteins; enzyme action
- structure and properties of cell membranes; passive and active transport
- structure and role of DNA and RNA
- replication; protein synthesis
- monohybrid inheritance
- gene mutations
- principles of gene therapy; social and ethical issues.

### Assessment:

This unit is assessed by means of a written examination paper, which lasts 1 hour 30 minutes.

**AS Unit 2: Development, Plants and the Environment****\*Unit code 6BI02**

- Externally assessed
- Availability: June

**40%  
of the  
total AS  
marks****20% of  
the total  
GCE  
marks****Content summary:**

- cell structure and ultrastructure of eukaryote and prokaryote cells: cell specialisation
- the role of meiosis
- genotype and environmental influence
- stem cell research and its implications
- biodiversity, adaptations and natural selection
- principles of taxonomy
- plant cell structure
- transport of water in plants
- uses of plant products.

**Assessment:**

This unit is assessed by means of a written examination paper, which lasts 1 hour 30 minutes.

## A Specification at a glance

### AS Unit 3: Practical Biology and Research Skills

\*Unit code 6BI03

- Internally assessed
- Availability: June

**20%  
of the  
total AS  
marks**

**10% of  
the total  
GCE  
marks**

#### Summary:

Students write a report, either a record of a visit to a site of biological interest or a report of research into a biological topic.

Students' practical skills will be assessed by the teacher against criteria provided in the specification. Please see Unit 3 Section 9.1 Part 1: Practical biology skills on page 77.

#### Assessment:

Teachers have the option of marking the report and having it moderated by Edexcel, or having it externally marked by Edexcel. The work must reflect the standard at Advanced Subsidiary level.

### A2 Unit 4: The Natural Environment and Species Survival

\*Unit code 6BI04

- Externally assessed
- Availability: June

**40%  
of the  
total A2  
marks**

**20% of  
the total  
GCE  
marks**

#### Content summary:

- photosynthesis; energy transfer within ecosystems
- evidence for global warming
- evolution through natural selection and speciation
- nutrient recycling
- DNA profiling and PCR
- structure of bacteria and viruses
- infectious diseases (eg AIDS and TB) and immunology.

#### Assessment:

This unit is assessed by means of a written examination paper, which lasts 1 hour 30 minutes.

A2 Unit 5: Energy, Exercise and Coordination	*Unit code 6BI05	
<ul style="list-style-type: none"> <li>■ Externally assessed</li> <li>■ Availability: June</li> </ul>	<b>40% of the total A2 marks</b>	<b>20% of the total GCE marks</b>
<p><b>Content summary:</b></p> <ul style="list-style-type: none"> <li>■ ATP, glycolysis, anaerobic/aerobic respiration</li> <li>■ control and functioning of heart; ventilation and cardiac output</li> <li>■ homeostasis</li> <li>■ the nervous system</li> <li>■ impact of exercise on body, and improving performance</li> <li>■ hormonal coordination</li> <li>■ brain structure and development</li> <li>■ imbalances in brain chemicals</li> <li>■ Human Genome Project.</li> </ul> <p><b>Assessment:</b></p> <p>This unit is assessed by means of a written examination paper, which lasts 1 hour 45 minutes.</p>		

A2 Unit 6: Practical Biology and Investigative Skills	*Unit code 6BI06	
<ul style="list-style-type: none"> <li>■ Internally assessed</li> <li>■ Availability: June</li> </ul>	<b>20% of the total A2 marks</b>	<b>10% of the total GCE marks</b>
<p><b>Summary:</b></p> <p>Students will complete a written report of an experimental investigation, which they have devised and carried out.</p> <p><b>Assessment:</b></p> <p>Teachers have the option of marking the report or having it externally marked by Edexcel. The work must reflect the standard expected at Advanced GCE level.</p>		

\* See *Appendix 5* for description of this code and all other codes relevant to this qualification.

# B Specification overview

## Summary of assessment requirements

Unit number and unit title	Level	Assessment information	Number of marks allocated in the unit
Unit 1: Lifestyle, Transport, Genes and Health	AS	<p>This unit is assessed by means of a written examination paper, which lasts 1 hour 30 minutes and will include:</p> <ul style="list-style-type: none"> <li>■ objective questions</li> <li>■ structured questions</li> <li>■ short-answer questions</li> </ul> <p>and will also cover:</p> <ul style="list-style-type: none"> <li>■ <i>How Science Works</i></li> <li>■ practical-related questions.</li> </ul>	80 marks
Unit 2: Development, Plants and the Environment	AS	<p>This unit is assessed by means of a written examination paper, which lasts 1 hour 30 minutes and will include:</p> <ul style="list-style-type: none"> <li>■ objective questions</li> <li>■ structured questions</li> <li>■ short-answer questions</li> </ul> <p>and will also cover:</p> <ul style="list-style-type: none"> <li>■ <i>How Science Works</i></li> <li>■ practical-related questions.</li> </ul>	80 marks
Unit 3: Practical Biology and Research Skills	AS	<p>Students will submit a written report of between 1500 and 2000 words which will be marked by the teacher and moderated by Edexcel or externally marked by Edexcel. The report may be either a record of a visit to a site of biological interest or a report of research into a biological topic.</p> <p>During the course of teaching Units 1 and 2 teachers will observe students carrying out practical work and will be required to submit a verification of practical skills record based on the recommended core practicals – see page 17.</p> <p>There is no separate content for this unit.</p>	40 marks
Unit 4: The Natural Environment and Species Survival	A2	<p>This unit is assessed by means of a written examination paper, which lasts 1 hour 30 minutes and will include:</p> <ul style="list-style-type: none"> <li>■ practical-related questions</li> <li>■ structured questions</li> <li>■ short-answer questions</li> </ul> <p>and will also cover:</p> <ul style="list-style-type: none"> <li>■ <i>How Science Works</i></li> <li>■ practical-related questions.</li> </ul>	90 marks

Unit number and unit title	Level	Assessment information	Number of marks allocated in the unit
Unit 5: Energy, Exercise and Coordination	A2	<p>This unit is assessed by means of a written examination paper, which lasts 1 hour 45 minutes and will include: objective questions</p> <ul style="list-style-type: none"> <li>■ structured questions</li> <li>■ short-answer questions</li> </ul> <p>and will also cover:</p> <ul style="list-style-type: none"> <li>■ <i>How Science Works</i></li> <li>■ practical-related questions.</li> </ul> <p>A third of the marks is related to specified pre-released reading.</p>	90 marks
Unit 6: Practical Biology and Investigative Skills	A2	<p>Students will complete an individual investigation. This is a written report of an experimental investigation, which they have devised and carried out and includes synoptic assessment. This piece of work will be marked by the teacher and moderated by Edexcel or externally marked by Edexcel.</p> <p>During the course of teaching Units 4 and 5 teachers will observe students carrying out practical work and will be required to submit a verification of practical skills record based on the recommended core practicals and the individual investigation.</p> <p>There is no separate content for this unit.</p>	45 marks

### Information for international centres

A 100 per cent examination option is available **ONLY** to international centres wishing to take GCE Biology. This will take the form of alternative written papers for Units 3 and 6.

This option is **not** available for home centres.

International private centres, including all centres entering candidates via the British Council, are not permitted to enter candidates for internal assessment and therefore must take the alternative written papers.

For further details please refer to the Edexcel international website [www.edexcel-international.org](http://www.edexcel-international.org).

### Assessment objectives and weightings

		% in AS	% in A2	% in GCE
<b>AO1</b>	Knowledge and understanding of science and of <i>How Science Works</i>	30–34%	26–30%	30–34%
<b>AO2</b>	Application of knowledge and understanding of science and of <i>How Science Works</i>	34–40%	42–48%	38–44%
<b>AO3</b>	How Science Works	28%	26%	27%
<b>Total</b>		100%	100%	100%

### Relationship of assessment objectives to units

Unit number	Assessment objective			
	AO1	AO2	AO3	Total for AO1, AO2 AO3
Unit 1	8–9%	8–9%	3%	19–21
Unit 2	8–9%	8–9%	3%	19–21
Unit 3	1%	1–2%	8%	10–11
Unit 4	7–8%	10–11%	2%	14–21
Unit 5	6–7%	10–12%	2%	18–21
Unit 6	–	1%	9%	10
<b>Total for Advanced GCE</b>	<b>30–34%</b>	<b>38–44%</b>	<b>27%</b>	<b>100</b>

### Qualification summary

#### Subject criteria

The General Certificate of Education is part of the Level 3 provision. This specification is based on the Advanced Subsidiary GCE and Advanced GCE subject criteria for Science, which is prescribed by the regulatory authorities and is mandatory for all awarding bodies.

**Aims**

The aims of the GCE in Biology are to enable students to:

- a develop their interest in, and enthusiasm for, biology including developing an interest in further study and careers in the subject
- b appreciate how society makes decisions about biology-related issues and how biology contributes to the success of the economy and society
- c develop and demonstrate a deeper appreciation of the skills, knowledge and understanding of *How Science Works*
- d develop essential knowledge and understanding of different areas of biology and how they relate to each other.

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**AS/A2 Knowledge and understanding**

This Advanced Subsidiary and Advanced GCE specification requires students to:

- recognise, recall and show understanding of scientific knowledge
- select, organise and communicate relevant information in a variety of forms
- analyse and evaluate scientific knowledge and processes
- apply scientific knowledge and processes to unfamiliar situations
- assess the validity, reliability and credibility of scientific information.

### AS/A2 Practical biology and investigative skills

This Advanced Subsidiary and Advanced GCE specification requires students to:

- use theories, models and ideas to develop and modify scientific explanations
- use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas
- use appropriate methodology, including ICT, to answer scientific questions and solve scientific problems
- carry out experimental and investigative activities, including appropriate risk management, in a range of contexts
- analyse and interpret data to provide evidence, recognising correlations and casual relationships
- evaluate methodology, evidence and data, and resolve conflicting evidence
- appreciate the tentative nature of scientific knowledge
- communicate information and ideas in appropriate ways using appropriate terminology
- consider applications and implications of science and appreciate their associated benefits and risks
- consider ethical issues in the treatment of humans, other organisms and the environment
- appreciate the role of the scientific community in validating new knowledge and ensuring integrity
- appreciate the ways in which science is used to inform decision making about issues to benefit society.

## How Science Works

*How Science Works* is a newly introduced section of the GCE Science criteria, that builds on from the Key Stage 4 Programme of Study for science. The table below takes the statements from the criteria and gives guidance on how these statements will be assessed in terms of what we expect the student to know, understand or be able to do. This table is referred to in each of the units. *How Science Works* will be assessed in the context of the unit content. *How Science Works* is mapped to the learning outcomes in *Appendix 3* on page 123.

Criteria	Learning outcome
1 Use theories, models and ideas to develop and modify scientific explanations	a) Explain how the development of scientific theories involves hypothesising, collecting and interpreting data and using creative thinking. b) Explain the importance of modelling as way of developing scientific understanding.
2 Use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas	a) Distinguish between questions that science can address, and those which science cannot address. b) Identify scientific questions or problems within a given context. c) Apply scientific theories to answer scientific questions or address scientific problems.
3 Use appropriate methodology, including ICT, to answer scientific questions and solve scientific problems	Justify methods, techniques and processes used during scientific investigations, including use of ICT, to collect valid and reliable data and produce scientific theories for a chosen question or problem.
4 Carry out experimental and investigative activities, including appropriate risk management, in a range of contexts	Produce a risk assessment before carrying out a range of practical work.
5 Analyse and interpret data to provide evidence, recognising correlations and causal relationships	a) Analyse data including use of: <ul style="list-style-type: none"> <li>■ descriptive statistics (mean, mode and median, error bars, standard deviation identification of outliers and range)</li> <li>■ graphic representation to identify patterns and relationships (eg correlation and cause)</li> <li>■ appropriate statistical tests (A2 only).</li> </ul> b) Interpret data with reference to the methods of analysis used.
6 Evaluate methodology, evidence and data, and resolve conflicting evidence	Evaluate the validity of inferences made from data in terms of the methods, techniques and processes used to collect and analyse the data, recognising any systematic or random errors present or conflicting evidence.
7 Appreciate the tentative nature of scientific knowledge	Explain how scientific theories are developed, refined, supported or refuted as new data or new interpretations of data become available.
8 Communicate information and ideas in appropriate ways using appropriate terminology	Present scientific information using text, graphics and other media as appropriate using scientific terminology with reference to data and credible sources.

## B Specification overview

Criteria	Learning outcome
9 Consider applications and implications of science and appreciate their associated benefits and risks	<ul style="list-style-type: none"><li>a) Evaluate activities in terms of their associated benefits and risks to humans, other organisms and the environment.</li><li>b) Discuss the risk associated with an activity in terms of the actual level of the risk and its potential consequences, associated uncertainties, and the factors affecting people's perception of the risk.</li></ul>
10 Consider ethical issues in the treatment of humans, other organisms and the environment	<ul style="list-style-type: none"><li>a) Identify ethical issues arising from the application of science as it impacts on humans, other organisms and the environment.</li><li>b) Discuss scientific solutions from a range of ethical viewpoints.</li></ul>
11 Appreciate the role of the scientific community in validating new knowledge and ensuring integrity	<ul style="list-style-type: none"><li>a) Discuss the importance of critical evaluation of new data or new interpretations of data which challenge established scientific theories or propose new theories.</li><li>b) Describe how the process of communication through journals and conferences, and peer review contribute to validation of new scientific theories by the scientific community.</li></ul>
12 Appreciate the ways in which society uses science to inform decision-making	Discuss how science influences decisions on an individual, local, national or international level.

# C Biology unit content

## Concept-led approach

Unit 1 Lifestyle, Transport, Genes and Health 21

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Unit 2 Development, Plants and the Environment 27

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Unit 4 The Natural Environment and Species Survival 33

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Unit 5 Energy, Exercise and Coordination 39

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## Context-led approach (based on the Salters-Nuffield Advanced Biology Project)

Unit 1 Lifestyle, Transport, Genes and Health 47

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Unit 2 Development, Plants and the Environment 55

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Unit 4 The Natural Environment and Species Survival 61

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Unit 5 Energy, Exercise and Coordination 67

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## Generic units (Concept and Context)

Unit 3 Practical Biology and Research Skills 77

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Unit 6 Practical Biology and Investigative Skills 85

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## Course structure

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- Edexcel's GCE in Biology comprises six units and contains an Advanced Subsidiary subset of three AS units.
- The Advanced Subsidiary GCE is the first half of the GCE course and consists of Units 1, 2 and 3. It may be awarded as a discrete qualification or contribute 50 per cent of the total Advanced GCE marks.
- The full Advanced GCE award consists of the three AS units (1, 2 and 3), plus three A2 units (Units 4, 5 and 6) which make up the other 50 per cent of the Advanced GCE. Students wishing to take the full Advanced GCE must, therefore, complete all six units.
- The structure of this qualification allows teachers to construct a course of study which can be taught and assessed either as:
  - ◆ distinct modules of teaching and learning with related units of assessment taken at appropriate stages during the course; or
  - ◆ a linear course which is assessed in its entirety at the end.

## Introduction to the context and concept approaches

Each unit may be taught based on either a context approach or a concept approach:

1. **Concept approach** – starts on page 19.

This approach begins with a study of the theories and principals of biology and then explores their practical applications.

2. **Context approach** – starts on page 45.

This approach begins with the consideration of an application that draws on many different areas of biology. The theories and principals of biology that apply to this application are then studied. This approach is based on the Salters–Nuffield Advanced Biology (SNAB) project.

The two approaches are based on common biological content and assessment. The difference is in the presentation of the learning outcomes of Units 1, 2, 4 and 5 to reflect these approaches.

Teachers may select the approach that best meets the needs of their students. Centres may use both approaches, for example, by allowing one group of students to follow one approach and another group of students to follow the other approach. These different approaches lead to the same assessment for each unit. A mix of approaches can be used, if desired.

## Introduction to the recommended core practicals

The recommended core practicals are identified in each unit: **they are the learning outcomes which are emboldened.**

It is expected that all students will have experience of these practicals. Practical-related questions will be asked in the written examination papers and will be based on the knowledge and understanding of the recommended core practicals.



# CONCEPT-LED APPROACH

**The following section shows how the specification  
may be taught using the concept-led approach**



## 1.1 Unit description

### Topic 1: Lifestyle, health and risk

This topic begins with a consideration of the structure and functions of a number of molecules, including water, carbohydrates and triglycerides. The structure and function of the cardiovascular system is also included as an introduction to the ways in which diet and lifestyle factors may affect the heart and circulatory system. Ideas about correlation, causation and the concept of risks to health are covered.

### Topic 2: Genes and health

This topic begins with a consideration of the structure and functions of the cell membrane and gas exchange surfaces. The structure and properties of proteins, enzyme and nucleic acids lead to the genetic code and protein synthesis. Principles of inheritance, gene therapy and genetic screening are included, giving opportunities for discussion of the social and ethical issues surrounding genetic screening for genetic conditions.

## 1.2 Assessment information

This unit is assessed by means of a written examination paper, which carries 80 marks, lasts 1 hour 30 minutes and will include:

- objective questions
- structured questions
- short-answer questions

and will also cover:

- *How Science Works*
- practical-related questions.

### 1.3 Topic 1: Lifestyle, health and risk

Students will be assessed on their ability to:

- 1 Demonstrate knowledge and understanding of the practical and investigative skills identified in numbers 4 and 5 in the table of *How Science Works* on page 13 of this specification.
- 2 Explain the importance of water as a solvent in transport, including its dipole nature.
- 3 Distinguish between monosaccharides, disaccharides and polysaccharides (glycogen and starch – amylose and amylopectin) and relate their structures to their roles in providing and storing energy ( $\beta$ -glucose and cellulose are not required in this topic).
- 4 Describe how monosaccharides join to form disaccharides (sucrose, lactose and maltose) and polysaccharides (glycogen and amylose) through condensation reactions forming glycosidic bonds, and how these can be split through hydrolysis reactions.
- 5 Describe the synthesis of a triglyceride by the formation of ester bonds during condensation reactions between glycerol and three fatty acids and recognise differences between saturated and unsaturated lipids.
- 6 Explain why many animals have a heart and circulation (mass transport to overcome limitations of diffusion in meeting the requirements of organisms).
- 7 Describe the cardiac cycle (atrial systole, ventricular systole and diastole) and relate the structure and operation of the mammalian heart to its function, including the major blood vessels.
- 8 Explain how the structures of blood vessels (capillaries, arteries and veins) relate to their functions.
- 9 **Describe how the effect of caffeine on heart rate in *Daphnia* can be investigated practically, and discuss whether there are ethical issues in the use of invertebrates.**

- 10 Describe the blood clotting process (thromboplastin release, conversion of prothrombin to thrombin and fibrinogen to fibrin) and its role in cardiovascular disease (CVD).
- 11 Explain the course of events that leads to atherosclerosis (endothelial damage, inflammatory response, plaque formation, raised blood pressure).
- 12 Describe the factors that increase the risk of CVD (genetic, diet, age, gender, high blood pressure, smoking and inactivity).
- 13 Describe the benefits and risks of treatments for CVD (antihypertensives, plant statins, anticoagulants and platelet inhibitory drugs).
- 14 Analyse and interpret data on the possible significance for health of blood cholesterol levels and levels of high-density lipoproteins (HDLs) and low-density lipoproteins (LDLs). Describe the evidence for a causal relationship between blood cholesterol levels (total cholesterol and LDL cholesterol) and CVD.
- 15 Discuss how people use scientific knowledge about the effects of diet (including obesity indicators), exercise and smoking to reduce their risk of coronary heart disease.
- 16 **Describe how to investigate the vitamin C content of food and drink.**
- 17 Analyse data on energy budgets and diet so as to be able to discuss the consequences of energy imbalance, including weight loss, weight gain, and development of obesity.
- 18 Analyse and interpret quantitative data on illness and mortality rates to determine health risks (including distinguishing between correlation and causation and recognising conflicting evidence).

- 19 Evaluate design of studies used to determine health risk factors (including sample selection and sample size used to collect data that is both valid and reliable).
- 20 Explain why people's perceptions of risks are often different from the actual risks (including underestimating and overestimating the risks due to diet and other lifestyle factors in the development of heart disease).

## 1.4 Topic 2: Genes and health

Students will be assessed on their ability to:

- 1 Demonstrate knowledge and understanding of the practical and investigative skills identified in numbers 4 and 5 in the table of *How Science Works* on page 13 of this specification.
- 2 Explain how models such as the fluid mosaic model of cell membranes are interpretations of data used to develop scientific explanations of the structure and properties of cell membranes.
- 3 Explain what is meant by osmosis in terms of the movement of free water molecules through a partially permeable membrane (consideration of water potential is not required).
- 4 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.
- 5 **Describe how membrane structure can be investigated practically, eg by the effect of alcohol concentration or temperature on membrane permeability.**
- 6 Describe the properties of gas exchange surfaces in living organisms (large surface area to volume ratio, thickness of surface, difference in concentration) and explain how the structure of the mammalian lung is adapted for rapid gaseous exchange.

- 7 Describe the basic structure of an amino acid (structures of specific amino acids are not required) and the formation of polypeptides and proteins (as amino acid monomers linked by peptide bonds in condensation reactions) and explain the significance of a protein's primary structure in determining its three-dimensional structure and properties (globular and fibrous proteins and types of bonds involved in three-dimensional structure).
- 8 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, catalysing a wide range of intracellular and extracellular reactions.
- 9 **Describe how enzyme concentrations can affect the rates of reactions and how this can be investigated practically by measuring the initial rate of reaction.**
- 10 Describe the basic structure of mononucleotides (as a deoxyribose or ribose linked to a phosphate and a base, ie thymine, uracil, cytosine, adenine or guanine) and the structures of DNA and RNA (as polynucleotides composed of mononucleotides linked through condensation reactions) and describe how complementary base pairing and the hydrogen bonding between two complementary strands are involved in the formation of the DNA double helix.
- 11 Describe DNA replication (including the role of DNA polymerase), and explain how Meselson and Stahl's classic experiment provided new data that supported the accepted theory of replication of DNA and refuted competing theories.
- 12 Explain the nature of the genetic code (triplet code only; non-overlapping and degenerate not required at AS).
- 13 Describe a gene as being a sequence of bases on a DNA molecule coding for a sequence of amino acids in a polypeptide chain.
- 14 Outline the process of protein synthesis, including the role of transcription, translation, messenger RNA, transfer RNA and the template (antisense) DNA strand (details of the mechanism of protein synthesis on ribosomes are not required at AS).

- 15 Explain how errors in DNA replication can give rise to mutations and explain how cystic fibrosis results from one of a number of possible gene mutations.
- 16 Explain the terms gene, allele, genotype, phenotype, recessive, dominant, homozygote and heterozygote, and explain monohybrid inheritance, including the interpretation of genetic pedigree diagrams, in the context of traits such as cystic fibrosis, albinism, thalassaemia, garden pea height and seed morphology.
- 17 Explain how the expression of a gene mutation in people with cystic fibrosis impairs the functioning of the gaseous exchange, digestive and reproductive systems.
- 18 Describe the principles of gene therapy and distinguish between somatic and germ line therapy.
- 19 Explain the uses of genetic screening: identification of carriers, preimplantation genetic diagnosis and prenatal testing (amniocentesis and chorionic villus sampling) and discuss the implications of prenatal genetic screening.
- 20 Identify and discuss the social and ethical issues related to genetic screening from a range of ethical viewpoints.

## 2.1 Unit description

### Topic 3: The voice of the genome

This topic begins with an overview of cell structure and considers how cell ultrastructure is related to function. Cell division and cell aggregation to form tissues and organs are also included. The topic then considers meiosis, the formation of gametes, fertilisation, stem cells, gene expression and cell differentiation. The role of the genotype and effect of the environment on phenotype is also stressed.

### Topic 4: Biodiversity and natural resources

This topic begins with a comparison of the structure of a typical plant cell with that of an animal cell, and the structure and roles of cellulose and starch. The relationship between plant tissues, xylem and sclerenchyma, is also included. The topic continues with a consideration of the importance of plant products to humans, species diversity, and how diversity arises through natural selection and evolutionary change. The role of zoos in the conservation of endangered species is also described.

## 2.2 Assessment information

This unit is assessed by means of a written examination paper, which carries 80 marks, lasts 1 hour 30 minutes and will include:

- objective questions
- structured questions
- short-answer questions

and will also cover:

- *How Science Works*
- practical-related questions.

The unit is the same size as Unit 1, to allow for time to develop practical skills for Unit 3 assessment.

## 2.3 Topic 3: The voice of the genome

Students will be assessed on their ability to:

- 1 Demonstrate knowledge and understanding of the practical and investigative skills identified in numbers 4 and 5 in the table of *How Science Works* on page 13 of this specification.
- 2 Distinguish between eukaryotic and prokaryotic cells in terms of their structure and ultrastructure.
- 3 Describe the ultrastructure of an animal (eukaryotic) cell (nucleus, nucleolus, ribosomes, rough and smooth endoplasmic reticulum, mitochondria, centrioles, lysosomes, and Golgi apparatus) and recognise these organelles from EM images.
- 4 Explain the role of the rough endoplasmic reticulum (rER) and the Golgi apparatus in protein transport within cells and including its role in formation of extracellular enzymes.
- 5 Describe how the cells of multicellular organisms can be organised into tissues, tissues into organs and organs into systems.
- 6 Explain the role of mitosis and the cell cycle for growth and asexual reproduction.
- 7 **Describe the stages of mitosis and how to prepare and stain a root tip squash in order to observe them practically.**
- 8 Explain the role of meiosis in the production of gametes and genetic variation through recombination of alleles and genes including independent assortment and crossing over (details of the stages of meiosis are not required).
- 9 Explain how mammalian gametes are specialised for their functions.

- 10 Describe the process of fertilisation in mammals and flowering plants (starting with the acrosome reaction in mammals and pollen tube growth in plants and ending with the fusion of the nuclei) and explain the importance of fertilisation in sexual reproduction.
- 11 Explain what is meant by the terms stem cell, pluripotency and totipotency and discuss the way society uses scientific knowledge to make decisions about the use of stem cells in medical therapies (eg regulatory authorities relating to human embryo research, ability of stem cells to develop into specialised tissues, potential sources of stem cells, who could benefit from the therapies, procedures to obtain stem cells and their risks).
- 12 **Describe how totipotency can be demonstrated practically using plant tissue culture techniques.**
- 13 Explain how cells become specialised through differential gene expression, producing active mRNA leading to synthesis of proteins, which in turn control cell processes or determine cell structure in animals and plants (details of transcription factors are not required at AS).
- 14 Explain how a phenotype is the result of an interaction between genotype and the environment (eg animal hair colour, human height, monoamine oxidase A (MAOA) and cancers), but the data on the relative contributions of genes and environment is often difficult to interpret.
- 15 Explain how some phenotypes are affected by alleles at many loci (polygenic inheritance) as well as the environment (eg height) and how this can give rise to phenotypes that show continuous variation.

## 2.4 Topic 4: Biodiversity and natural resources

Students will be assessed on their ability to:

- 1 Demonstrate knowledge and understanding of the practical and investigative skills identified in numbers 4 and 5 in the table of *How Science Works* on page 13 of this specification.
- 2 Compare the ultrastructure of plant cells (cell wall, chloroplasts, amyloplasts, vacuole, tonoplast, plasmodesmata, pits and middle lamella) with that of animal cells.
- 3 Compare the structure and function of the polysaccharides starch and cellulose including the role of hydrogen bonds between  $\beta$ -glucose molecules in the formation of cellulose microfibrils.
- 4 Explain how the arrangement of cellulose microfibrils in plant cell walls and secondary thickening contribute to the physical properties of plant fibres, which can be exploited by humans.
- 5 Compare the structures, position in the stem and function of sclerenchyma fibres (support) and xylem vessels (support and transport of water and mineral ions).
- 6 Describe how the uses of plant fibres and starch may contribute to sustainability, eg plant-based products to replace oil-based plastics.
- 7 Identify sclerenchyma fibres and xylem vessels as seen through a light microscope.
- 8 **Describe how to determine the tensile strength of plant fibres practically.**
- 9 Explain the importance of water and inorganic ions (nitrate, calcium ions and magnesium ions) to plants.
- 10 **Describe how to investigate plant mineral deficiencies practically.**
- 11 **Describe how to investigate the antimicrobial properties of plants.**

- 12 Compare historic drug testing with contemporary drug testing protocols, eg William Withering's digitalis soup; double blind trials; placebo; three-phased testing.
- 13 Explain the terms biodiversity and endemism and describe how biodiversity can be measured within a habitat using species richness and within a species using genetic diversity, eg variety of alleles in a gene pool.
- 14 Describe the concept of niche and discuss examples of adaptation of organisms to their environment (behavioural, physiological and anatomical).
- 15 Describe how natural selection can lead to adaptation and evolution.
- 16 Discuss the process and importance of critical evaluation of new data by the scientific community, which leads to new taxonomic groupings (ie three domains based on molecular phylogeny).
- 17 Discuss and evaluate the methods used by zoos and seedbanks in the conservation of endangered species and their genetic diversity (eg scientific research, captive breeding programmes, reintroduction programmes and education).



### 3.1 Unit description

#### Topic 5: On the wild side

This topic builds an appreciation that photosynthesis is the primary process that underpins the majority of ecosystems, and provides students with an understanding of how ecosystems work. The topic continues by looking at whether climate change will lead to extinction of species or evolution by natural selection, and looks at the evidence for global warming and its effects on plants and animals. By the end of the topic students should appreciate how scientific understanding can make us aware of our responsibilities as stewards of the environment.

#### 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 identity of a person or other animal, and to establish the time and cause of death of an organism, including humans. 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.

### 3.2 Assessment information

This unit is assessed by means of a written examination paper, which carries 90 marks, lasts 1 hour 30 minutes and will include:

- objective questions
- structured questions
- short-answer questions

and will also cover:

- *How Science Works*
- practical-related questions.

### 3.3 Topic 5: On the wild side

#### Students will be assessed on their ability to:

- 1 Demonstrate knowledge and understanding of the *How Science Works* areas listed in the table on page 13 of this specification.
- 2 Describe the structure of chloroplasts in relation to their role in photosynthesis.
- 3 Describe the overall reaction of photosynthesis as requiring energy from light to split apart the strong bonds in water molecules, storing the hydrogen in a fuel (glucose) by combining it with carbon dioxide and releasing oxygen into the atmosphere.
- 4 Describe the light-dependent reactions of photosynthesis including how light energy is trapped by exciting electrons in chlorophyll and the role of these electrons in generating ATP, and reducing NADP in photophosphorylation and producing oxygen through photolysis of water.
- 5 Describe how phosphorylation of ADP requires energy and how hydrolysis of ATP provides an immediate supply of energy for biological processes.
- 6 Describe the light-independent reactions as reduction of carbon dioxide using the products of the light-dependent reactions (carbon fixation in the Calvin cycle, the role of GP, GALP, RuBP and RUBISCO) and describe the products as simple sugars that are used by plants, animals and other organisms in respiration and the synthesis of new biological molecules (including polysaccharides, amino acids, lipids and nucleic acids).
- 7 Carry out calculations of net primary productivity and explain the relationship between gross primary productivity, net primary productivity and plant respiration.
- 8 Calculate the efficiency of energy transfers between trophic levels.

- 9 Discuss how understanding the carbon cycle can lead to methods to reduce atmospheric levels of carbon dioxide (including the use of biofuels and reforestation).
- 10 Explain that the numbers and distribution of organisms in a habitat are controlled by biotic and abiotic factors.
- 11 **Describe how to carry out a study on the ecology of a habitat to produce valid and reliable data (including the use of quadrats and transects to assess abundance and distribution of organisms and the measurement of abiotic factors, eg solar energy input, climate, topography, oxygen availability and edaphic factors).**
- 12 Explain how the concept of niche accounts for distribution and abundance of organisms in a habitat.
- 13 Describe the concept of succession to a climax community.
- 14 Outline the causes of global warming – including the role of greenhouse gases (carbon dioxide and methane, CH<sub>4</sub>) in the greenhouse effect.
- 15 Describe the effects of global warming (rising temperature, changing rainfall patterns and seasonal cycles) on plants and animals (distribution of species, development and life cycles).
- 16 Explain the effect of increasing temperature on the rate of enzyme activity in plants, animals and micro-organisms.
- 17 **Describe how to investigate the effects of temperature on the development of organisms (eg seedling growth rate, brine shrimp hatch rates).**
- 18 Analyse and interpret different types of evidence for global warming and its causes (including records of carbon dioxide levels, temperature records, pollen in peat bogs and dendrochronology) recognising correlations and causal relationships.
- 19 Describe that data can be extrapolated to make predictions, that these are used in models of future global warming, and that these models have limitations.

- 20 Discuss the way in which scientific conclusions about controversial issues, such as what actions should be taken to reduce global warming or the degree to which humans are affecting global warming, can sometimes depend on who is reaching the conclusions.
- 21 Describe how evolution (a change in the allele frequency) can come about through gene mutation and natural selection.
- 22 Explain how reproductive isolation can lead to speciation.
- 23 Describe the role of the scientific community in validating new evidence (including molecular biology, eg DNA, proteomics) supporting the accepted scientific theory of evolution (scientific journals, the peer review process, scientific conferences).

### 3.4 Topic 6: Infection, immunity and forensics

#### Students will be assessed on their ability to:

- 1 Demonstrate knowledge and understanding of the *How Science Works* areas listed in the table on page 13 of this specification.
- 2 Explain the nature of the genetic code (triplet code, non-overlapping and degenerate).
- 3 Explain the process of protein synthesis (transcription, translation messenger RNA, transfer RNA, ribosomes and the role of start and stop codons) and explain the roles of the template (antisense) DNA strand in transcription, codons on messenger RNA, anticodons on transfer RNA.
- 4 Explain how one gene can give rise to more than one protein through post-transcriptional changes to messenger RNA.
- 5 Describe how DNA profiling is used for identification and determining genetic relationships between organisms (plants and animals).

- 6 **Describe how DNA can be amplified using the polymerase chain reaction (PCR).**
- 7 **Describe how gel electrophoresis can be used to separate DNA fragments of different length.**
- 8 Distinguish between the structure of bacteria and viruses.
- 9 Describe the role of micro-organisms in the decomposition of organic matter and the recycling of carbon.
- 10 Describe the major routes pathogens may take when entering the body and explain the role of barriers in protecting the body from infection, including the roles of skin, stomach acid, gut and skin flora.
- 11 Explain how bacterial and viral infectious diseases have a sequence of symptoms that may result in death, including the diseases caused by *Mycobacterium tuberculosis* (TB) and Human Immunodeficiency Virus (HIV).
- 12 Describe the non-specific responses of the body to infection, including inflammation, lysozyme action, interferon and phagocytosis.
- 13 Explain the roles of antigens and antibodies in the body's immune response including the involvement of plasma cells, macrophages and antigen-presenting cells.
- 14 Distinguish between the roles of B cells (including B memory and B effector cells) and T cells (T helper, T killer and T memory cells) in the body's immune response.
- 15 Explain how individuals may develop immunity (natural, artificial, active, passive).
- 16 Discuss how the theory of an 'evolutionary race' between pathogens and their hosts is supported by the evasion mechanisms as shown by Human Immunodeficiency Virus (HIV) and *Mycobacterium tuberculosis* (TB).

- 17 Distinguish between bacteriostatic and bactericidal antibiotics.
- 18 **Describe how to investigate the effect of different antibiotics on bacteria.**
- 19 Describe how an understanding of the contributory causes of hospital acquired infections have led to codes of practice relating to antibiotic prescription and hospital practice relating to infection prevention and control.
- 20 Describe how to determine the time of death of a mammal by examining the extent of decomposition, stage of succession, forensic entomology, body temperature and degree of muscle contraction.

## 4.1 Unit description

### Topic 7: Run for your life

This topic begins with a study of muscle structure and function, and the ways in which energy is provided by means of aerobic and anaerobic respiration. The responses of the heart and respiratory system to exercise are included, with the concept of homeostasis and its importance in both the regulation of body temperature and at the molecular level with a reference to gene switching. The topic ends by considering the effects of both too much and too little exercise on the body, how medical technology is used in relation to sports, and the ethical positions with respect to the use of performance-enhancing substances by athletes.

### Topic 8: Grey matter

This topic begins by considering how plants detect and respond to changes in their environment. This is followed by details of the structure and function of the mammalian nervous system, including imaging techniques to investigate the brain. This is developed into an enquiry into how imbalances in brain chemicals may result in conditions such as Parkinson's disease and its treatment with drugs. The topic requires students to discuss the ethics of the Human Genome Project and to consider the risks and benefits associated with the use of genetically modified organisms.

## 4.2 Assessment information

This unit is assessed by means of a written examination paper, which carries 90 marks, lasts 1 hour 45 minutes and will include:

- objective questions
- structured questions
- short-answer questions

and will also cover:

- *How Science Works*
- practical-related questions.

One question will relate to a previously released scientific article that students will have studied during the course. Students may be asked to summarise the information in the article, and explain or comment upon the biology and other issues within the context of the article. The article may draw on knowledge and understanding from any of the four units 1, 2, 4, and 5. A different article will be provided each year and the examination questions will change to reflect this. This question carries a third of the marks of this unit.

## 4.3 Topic 7: Run for your life

**Students will be assessed on their ability to:**

- 1 Demonstrate knowledge and understanding of the *How Science Works* areas listed in the table on page 13 of this specification.
- 2 Describe the structure of a muscle fibre and explain the structural and physiological differences between fast and slow twitch muscle fibres.
- 3 Explain the contraction of skeletal muscle in terms of the sliding filament theory, including the role of actin, myosin, troponin, tropomyosin, calcium ions ( $\text{Ca}^{2+}$ ), ATP and ATPase.

- 4 Recall the way in which muscles, tendons, the skeleton and ligaments interact to enable movement, including antagonistic muscle pairs, extensors and flexors.
- 5 Describe the overall reaction of aerobic respiration as splitting of the respiratory substrate (eg glucose) to release carbon dioxide as a waste product and reuniting of hydrogen with atmospheric oxygen with the release of a large amount of energy.
- 6 **Describe how to investigate rate of respiration practically.**
- 7 Recall how phosphorylation of ADP requires energy and how hydrolysis of ATP provides an accessible supply of energy for biological processes.
- 8 Describe the roles of glycolysis in aerobic and anaerobic respiration, including the phosphorylation of hexoses, the production of ATP, reduced coenzyme and pyruvate acid (details of intermediate stages and compounds are not required).
- 9 Describe the role of the Krebs cycle in the complete oxidation of glucose and formation of carbon dioxide (CO<sub>2</sub>), ATP, reduced NAD and reduced FAD (names of other compounds are not required) and that respiration is a many-stepped process with each step controlled and catalysed by a specific intracellular enzyme.
- 10 Describe the synthesis of ATP by oxidative phosphorylation associated with the electron transport chain in mitochondria, including the role of chemiosmosis and ATPase.
- 11 Explain the fate of lactate after a period of anaerobic respiration in animals.
- 12 Understand that cardiac muscle is myogenic and describe the normal electrical activity of the heart, including the roles of the sinoatrial node (SAN), the atrioventricular node (AVN) and the bundle of His, and how the use of electrocardiograms (ECGs) can aid the diagnosis of cardiovascular disease (CVD) and other heart conditions.

- 13 Explain how variations in ventilation and cardiac output enable rapid delivery of oxygen to tissues and the 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.
- 14 **Describe how to investigate the effects of exercise on tidal volume and breathing rate using data from spirometer traces.**
- 15 Explain the principle of negative feedback in maintaining systems within narrow limits.
- 16 Discuss the concept of homeostasis and its importance in maintaining the body in a state of dynamic equilibrium during exercise, including the role of the hypothalamus and the mechanisms of thermoregulation.
- 17 Explain how genes can be switched on and off by DNA transcription factors including hormones.
- 18 Analyse and interpret data on possible disadvantages of exercising too much (wear and tear on joints, suppression of the immune system) and exercising too little (increased risk of obesity, coronary heart disease (CHD) and diabetes), recognising correlation and causal relationships.
- 19 Explain how medical technology, including the use of keyhole surgery and prostheses, is enabling those with injuries and disabilities to participate in sports, eg cruciate ligaments repair using keyhole surgery and knee joint replacement using prosthetics.
- 20 Outline two ethical positions relating to whether the use of performance-enhancing substances by athletes is acceptable.

## 4.4 Topic 8: Grey matter

**Students will be assessed on their ability to:**

- 1 Demonstrate knowledge and understanding of the *How Science Works* areas listed in the table on page 13 of this specification.
- 2 Describe how plants detect light using photoreceptors and how they respond to environmental cues.
- 3 Describe the structure and function of sensory, relay and motor neurones including the role of Schwann cells and myelination.
- 4 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 Describe the structure and function of synapses, including the role of neurotransmitters, such as acetylcholine.
- 6 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, sodium ions, cation channels and hyperpolarisation of rod cells in forming action potentials in the optic neurones.
- 7 Explain how the nervous systems of organisms can cause effectors to respond as exemplified by pupil dilation and contraction.
- 8 Compare mechanisms of coordination in plants and animals, ie nervous and hormonal, including the role of IAA in phototropism (details of individual mammalian hormones are not required).
- 9 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 (coordinate movement) and medulla oblongata (control the heartbeat).

- 10 Describe the use of magnetic resonance imaging (MRI), functional magnetic resonance imaging (fMRI) and computed tomography (CT) scans in medical diagnosis and investigating brain structure and function.
- 11 Discuss whether 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.
- 12 Describe the role animal models have played in developing explanations of human brain development and function, including Hubel and Wiesel's experiments with monkeys and kittens.
- 13 Consider the methods used to compare the contributions of nature and nurture to brain development, including evidence from the abilities of newborn babies, animal experiments, studies of individuals with damaged brain areas, twin studies and cross-cultural studies.
- 14 Describe how animals, including humans, can learn by habituation.
- 15 **Describe how to investigate habituation to a stimulus.**
- 16 Discuss the moral and ethical issues relating to the use of animals in medical research from two ethical standpoints.
- 17 Explain how imbalances in certain, naturally occurring, brain chemicals can contribute to ill health (eg dopamine in Parkinson's disease and serotonin in depression) and to the development of new drugs.
- 18 Explain the effects of drugs on synaptic transmissions, including the use of L-Dopa in the treatment of Parkinson's disease and the action of MDMA in ecstasy.
- 19 Discuss how the outcomes of the Human Genome Project are being used in the development of new drugs and the social, moral and ethical issues this raises.
- 20 Describe how drugs can be produced using genetically modified organisms (plants and animals and micro organisms).
- 21 Discuss the risks and benefits associated with the use of genetically modified organisms.

# CONTEXT-LED APPROACH BASED ON THE SALTERS-NUFFIELD ADVANCED BIOLOGY PROJECT

**The following section shows how the specification may be taught using a context-led approach. The outcomes in this section are presented in a different order to those in the section that contains the concept approach and therefore the outcomes do not appear in numerical order.**



## 5.1 Unit description

### Topic 1: Lifestyle, health and risk

This topic builds on students' knowledge and understanding of the functioning of the circulatory system and the importance of lifestyle choices to health. The role of diet and other lifestyle factors in maintenance of 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. Ideas about correlation, causation and the concept of risks to health are covered.

### Topic 2: Genes and health

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

## 5.2 Assessment information

This unit is assessed by means of a written examination paper, which carries 80 marks, lasts 1 hour 30 minutes and will include:

- objective questions
- structured questions
- short-answer questions

and will also cover:

- *How Science Works*
- practical-related questions.

### 5.3 Topic 1: Lifestyle, health and risk

Students will be assessed on their ability to:

- 1 Demonstrate knowledge and understanding of the practical and investigative skills identified in numbers 4 and 5 in the table of *How Science Works* on page 13 of this specification.
- 6 Explain why many animals have a heart and circulation (mass transport to overcome limitations of diffusion in meeting the requirements of organisms).
- 2 Explain the importance of water as a solvent in transport, including its dipole nature.
- 8 Explain how the structures of blood vessels (capillaries, arteries and veins) relate to their functions.
- 7 Describe the cardiac cycle (atrial systole, ventricular systole and diastole) and relate the structure and operation of the mammalian heart to its function, including the major blood vessels.
- 11 Explain the course of events that leads to atherosclerosis (endothelial damage, inflammatory response, plaque formation, raised blood pressure).
- 10 Describe the blood clotting process (thromboplastin release, conversion of prothrombin to thrombin and fibrinogen to fibrin) and its role in cardiovascular disease (CVD).
- 12 Describe the factors that increase the risk of CVD (genetic, diet, age, gender, high blood pressure, smoking and inactivity).
- 18 Analyse and interpret quantitative data on illness and mortality rates to determine health risks (including distinguishing between correlation and causation and recognising conflicting evidence).

- 19 Evaluate design of studies used to determine health risk factors (including sample selection and sample size used to collect data that is both valid and reliable).
- 20 Explain why people's perceptions of risks are often different from the actual risks (including underestimating and overestimating the risks due to diet and other lifestyle factors in the development of heart disease).
- 17 Analyse data on energy budgets and diet so as to be able to discuss the consequences of energy imbalance, including weight loss, weight gain, and development of obesity.
- 3 Distinguish between monosaccharides, disaccharides and polysaccharides (glycogen and starch – amylose and amylopectin) and relate their structures to their roles in providing and storing energy ( $\beta$ -glucose and cellulose are not required in this topic).
- 4 Describe how monosaccharides join to form disaccharides (sucrose, lactose and maltose) and polysaccharides (glycogen and amylose) through condensation reactions forming glycosidic bonds, and how these can be split through hydrolysis reactions.
- 5 Describe the synthesis of a triglyceride by the formation of ester bonds during condensation reactions between glycerol and three fatty acids and recognise differences between saturated and unsaturated lipids.
- 14 Analyse and interpret data on the possible significance for health of blood cholesterol levels and levels of high-density lipoproteins (HDLs) and low-density lipoproteins (LDLs). Describe the evidence for a causal relationship between blood cholesterol levels (total cholesterol and LDL cholesterol) and CVD.

- 9 **Describe how the effect of caffeine on heart rate in *Daphnia* can be investigated practically, and discuss whether there are ethical issues in the use of invertebrates.**
- 16 **Describe how to investigate the vitamin C content of food and drink.**
- 15 Discuss how people use scientific knowledge about the effects of diet (including obesity indicators), exercise and smoking to reduce their risk of coronary heart disease.
- 13 Describe the benefits and risks of treatments for CVD (antihypertensives, plant statins, anticoagulants and platelet inhibitory drugs).

## 5.4 Topic 2: Genes and health

**Students will be assessed on their ability to:**

- 1 Demonstrate knowledge and understanding of the practical and investigative skills identified in numbers 4 and 5 in the table of *How Science Works* on page 13 of this specification.
- 6 Describe the properties of gas exchange surfaces in living organisms (large surface area to volume ratio, thickness of surface, difference in concentration) and explain how the structure of the mammalian lung is adapted for rapid gaseous exchange.

- 2 Explain how models such as the fluid mosaic model of cell membranes are interpretations of data used to develop scientific explanations of the structure and properties of cell membranes.
- 5 **Describe how membrane structure can be investigated practically, eg by the effect of alcohol concentration or temperature on membrane permeability.**
- 3 Explain what is meant by osmosis in terms of the movement of free water molecules through a partially permeable membrane (consideration of water potential is not required).
- 4 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.
- 10 Describe the basic structure of mononucleotides (as a deoxyribose or ribose linked to a phosphate and a base, ie thymine, uracil, cytosine, adenine or guanine) and the structures of DNA and RNA (as polynucleotides composed of mononucleotides linked through condensation reactions) and describe how complementary base pairing and the hydrogen bonding between two complementary strands are involved in the formation of the DNA double helix.
- 14 Outline the process of protein synthesis, including the role of transcription, translation, messenger RNA, transfer RNA and the template (antisense) DNA strand (details of the mechanism of protein synthesis on ribosomes are not required at AS).
- 12 Explain the nature of the genetic code (triplet code only; non-overlapping and degenerate not required at AS).
- 13 Describe a gene as being a sequence of bases on a DNA molecule coding for a sequence of amino acids in a polypeptide chain.

- 7 Describe the basic structure of an amino acid (structures of specific amino acids are not required) and the formation of polypeptides and proteins (as amino acid monomers linked by peptide bonds in condensation reactions) and explain the significance of a protein's primary structure in determining its three-dimensional structure and properties (globular and fibrous proteins and types of bonds involved in three-dimensional structure).
- 8 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, catalysing a wide range of intracellular and extracellular reactions.
- 9 **Describe how enzyme concentrations can affect the rates of reactions and how this can be investigated practically by measuring the initial rate of reaction.**
- 11 Describe DNA replication (including the role of DNA polymerase), and explain how Meselson and Stahl's classic experiment provided new data that supported the accepted theory of replication of DNA and refuted competing theories.
- 15 Explain how errors in DNA replication can give rise to mutations and explain how cystic fibrosis results from one of a number of possible gene mutations.
- 16 Explain the terms: gene, allele, genotype, phenotype, recessive, dominant, homozygote and heterozygote; and explain monohybrid inheritance, including the interpretation of genetic pedigree diagrams, in the context of traits such as cystic fibrosis, albinism, thalassaemia, garden pea height and seed morphology.
- 17 Explain how the expression of a gene mutation in people with cystic fibrosis impairs the functioning of the gaseous exchange, digestive and reproductive systems.

- 18 Describe the principles of gene therapy and distinguish between somatic and germ line therapy.
- 19 Explain the uses of genetic screening: identification of carriers, preimplantation genetic diagnosis and prenatal testing (amniocentesis and chorionic villus sampling) and discuss the implications of prenatal genetic screening.
- 20 Identify and discuss the social and ethical issues related to genetic screening from a range of ethical viewpoints.



## 6.1 Unit description

### Topic 3: The voice of the genome

This topic follows the development of multicellular organisms from single cells to complex individuals. Cell structure and ultrastructure, cell division, the importance of fertilisation, the roles of stem cells, gene expression, cell differentiation and tissue organisation are all considered within this topic, as is the role of the genotype and the effect of environment on phenotype.

### Topic 4: Biodiversity and natural resources

The topic focuses on biodiversity and the wealth of natural resources used by humans. The meaning of biodiversity and how it can be measured is considered first and how all this diversity has come about through adaptation and natural selection. It has sections on both traditional and novel uses of plants and plant fibres and the use of chemical extracts from animals and plants. The concern for disappearing biodiversity and loss of potential natural resources is used to highlight the need for biologists to identify, name and classify species. The topic finishes by looking at the role of zoos in conservation of endangered species. General biological principles covered include the relationship of plant anatomy to function and the structure and role of cellulose and starch.

## 6.2 Assessment information

This unit is assessed by means of a written examination paper, which carries 80 marks, lasts 1 hour 30 minutes and will include:

- objective questions
- structured questions
- short-answer questions

and will also cover:

- *How Science Works*
- practical-related questions.

The unit is the same size as Unit 1, to allow for time to develop practical skills for Unit 3 assessment.

### 6.3 Topic 3: The voice of the genome

Students will be assessed on their ability to:

- 1 Demonstrate knowledge and understanding of the practical and investigative skills identified in numbers 4 and 5 in the table of *How Science Works* on page 13 of this specification.
- 3 Describe the ultrastructure of an animal (eukaryotic) cell (nucleus, nucleolus, ribosomes, rough and smooth endoplasmic reticulum, mitochondria, centrioles, lysosomes, and Golgi apparatus) and recognise these organelles from EM images.
- 4 Explain the role of the rough endoplasmic reticulum (rER) and the Golgi apparatus in protein transport within cells and including its role in formation of extracellular enzymes.
- 2 Distinguish between eukaryotic and prokaryotic cells in terms of their structure and ultrastructure.
- 6 Explain the role of mitosis and the cell cycle for growth and asexual reproduction.
- 7 **Describe the stages of mitosis and how to prepare and stain a root tip squash in order to observe them practically.**
- 9 Explain how mammalian gametes are specialised for their functions.
- 10 Describe the process of fertilisation in mammals and flowering plants (starting with the acrosome reaction in mammals and pollen tube growth in plants and ending with the fusion of the nuclei) and explain the importance of fertilisation in sexual reproduction.
- 8 Explain the role of meiosis in the production of gametes and genetic variation through recombination of alleles and genes including independent assortment and crossing over (details of the stages of meiosis are not required).

- 11 Explain what is meant by the terms stem cell, pluripotency and totipotency and discuss the way society uses scientific knowledge to make decisions about the use of stem cells in medical therapies (eg regulatory authorities relating to human embryo research, ability of stem cells to develop into specialised tissues, potential sources of stem cells, who could benefit from the therapies, procedures to obtain stem cells and their risks).
- 13 Explain how cells become specialised through differential gene expression, producing active mRNA leading to synthesis of proteins. which in turn control cell processes or determine cell structure in animals and plants (details of transcription factors are not required at AS).
- 5 Describe how the cells of multicellular organisms can be organised into tissues, tissues into organs and organs into systems.
- 14 Explain how phenotype is the result of an interaction between genotype and the environment (eg animal hair colour, human height, monoamine oxidase A (MAOA) and cancers), but the data on the relative contributions of genes and environment is often difficult to interpret.
- 15 Explain how some phenotypes are affected by alleles at many loci (polygenic inheritance) as well as the environment (eg height) and how this can give rise to phenotypes that show continuous variation.
- 12 **Describe how totipotency can be demonstrated practically using plant tissue culture techniques.**

## 6.4 Topic 4: Biodiversity and natural resources

Students will be assessed on their ability to:

- 1 Demonstrate knowledge and understanding of the practical and investigative skills identified in numbers 4 and 5 in the table of *How Science Works* on page 13 of this specification.
- 13 Explain the terms biodiversity and endemism and describe how biodiversity can be measured within a habitat using species richness and within a species using genetic diversity, eg variety of alleles in a gene pool.
- 14 Describe the concept of niche and discuss examples of adaptation of organisms to their environment (behavioural, physiological and anatomical).
- 15 Describe how natural selection can lead to adaptation and evolution.
- 2 Compare the ultrastructure of plant cells (cell wall, chloroplasts, amyloplasts, vacuole, tonoplast, plasmodesmata, pits and middle lamella) with that of animal cells.
- 3 Compare the structure and function of the polysaccharides starch and cellulose including the role of hydrogen bonds between  $\beta$ -glucose molecules in the formation of cellulose microfibrils.
- 5 Compare the structures, position in the stem and function of sclerenchyma fibres (support) and xylem vessels (support and transport of water and mineral ions).
- 4 Explain how the arrangement of cellulose microfibrils in plant cell walls and secondary thickening contribute to the physical properties of plant fibres, which can be exploited by humans.
- 7 Identify sclerenchyma fibres and xylem vessels as seen through a light microscope.
- 8 **Describe how to determine the tensile strength of plant fibres practically.**

- 9 Explain the importance of water and inorganic ions (nitrate, calcium ions and magnesium ions) to plants.
- 10 **Describe how to investigate plant mineral deficiencies practically.**
- 6 Describe how the uses of plant fibres and starch may contribute to sustainability, eg plant-based products to replace oil-based plastics.
- 12 Compare historic drug testing with contemporary drug testing protocols, eg William Withering's digitalis soup; double blind trials; placebo; three-phased testing.
- 11 **Describe how to investigate the antimicrobial properties of plants.**
- 16 Discuss the process and importance of critical evaluation of new data by the scientific community, which leads to new taxonomic groupings (ie three domains based on molecular phylogeny).
- 17 Discuss and evaluate the methods used by zoos and seedbanks in the conservation of endangered species and their genetic diversity (eg scientific research, captive breeding programmes, reintroduction programmes and education).



## 7.1 Unit description

### Topic 5: On the wild side

This topic builds an appreciation that photosynthesis is the primary process that underpins the majority of ecosystems, and provides students with an understanding of how ecosystems work. The topic continues by looking at whether climate change will lead to extinction of species or evolution by natural selection, and looks at the evidence for global warming and its effects on plants and animals. By the end of the topic students should appreciate how scientific understanding can make us aware of our responsibilities as stewards of the environment.

### 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 identity of a person or other animal, and to establish the time and cause of death of an organism, including humans. 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.

## 7.2 Assessment information

This unit is assessed by means of a written examination paper, which carries 90 marks, lasts 1 hour 30 minutes and will include:

- objective questions
- structured questions
- short-answer questions

and will also cover:

- *How Science Works*
- practical-related questions.

### 7.3 Topic 5: On the wild side

Students will be assessed on their ability to:

- 1 Demonstrate knowledge and understanding of the *How Science Works* areas listed in the table on page 13 of this specification.
- 11 **Describe how to carry out a study on the ecology of a habitat to produce valid and reliable data (including the use of quadrats and transects to assess abundance and distribution of organisms and the measurement of abiotic factors, eg solar energy input, climate, topography, oxygen availability and edaphic factors).**
- 10 Explain that the numbers and distribution of organisms in a habitat are controlled by biotic and abiotic factors.
- 12 Explain how the concept of niche accounts for distribution and abundance of organisms in a habitat.
- 13 Describe the concept of succession to a climax community.
- 14 Outline the causes of global warming – including the role of greenhouse gases (carbon dioxide and methane, CH<sub>4</sub>) in the greenhouse effect.
- 18 Analyse and interpret different types of evidence for global warming and its causes (including records of carbon dioxide levels, temperature records, pollen in peat bogs and dendrochronology) recognising correlations and causal relationships.
- 19 Describe that data can be extrapolated to make predictions, that these are used in models of future global warming, and that these models have limitations.
- 20 Discuss the way in which scientific conclusions about controversial issues, such as what actions should be taken to reduce global warming or the degree to which humans are affecting global warming, can sometimes depend on who is reaching the conclusions.

- 15 Describe the effects of global warming (rising temperature, changing rainfall patterns and changes in seasonal cycles) on plants and animals (distribution of species, development and life cycles).
- 16 Explain the effect of increasing temperature on the rate of enzyme activity in plants, animals and micro-organisms.
- 17 **Describe how to investigate the effects of temperature on the development of organisms (eg seedling growth rate, brine shrimp hatch rates).**
- 3 Describe the overall reaction of photosynthesis as requiring energy from light to split apart the strong bonds in water molecules, storing the hydrogen in a fuel (glucose) by combining it with carbon dioxide and releasing oxygen into the atmosphere.
- 5 Describe how phosphorylation of ADP requires energy and how hydrolysis of ATP provides an immediate supply of energy for biological processes.
- 4 Describe the light-dependent reactions of photosynthesis including how light energy is trapped by exciting electrons in chlorophyll and the role of these electrons in generating ATP, and reducing NADP in photophosphorylation and producing oxygen through photolysis of water.
- 6 Describe the light-independent reactions as reduction of carbon dioxide using the products of the light-dependent reactions (carbon fixation in the Calvin cycle, the role of GP, GALP, RuBP and RUBISCO) and describe the products as simple sugars that are used by plants, animals and other organisms in respiration and the synthesis of new biological molecules (including polysaccharides, amino acids, lipids and nucleic acids).
- 2 Describe the structure of chloroplasts in relation to their role in photosynthesis.

- 7 Carry out calculations of net primary productivity and explain the relationship between gross primary productivity, net primary productivity and plant respiration.
- 8 Calculate the efficiency of energy transfers between trophic levels.
- 9 Discuss how understanding the carbon cycle can lead to methods to reduce atmospheric levels of carbon dioxide (including the use of biofuels and reforestation).
- 21 Describe how evolution (a change in the allele frequency) can come about through gene mutation and natural selection.
- 23 Describe the role of the scientific community in validating new evidence (including molecular biology, eg DNA, proteomics) supporting the accepted scientific theory of evolution (scientific journals, the peer review process, scientific conferences).
- 22 Explain how reproductive isolation can lead to speciation.

## 7.4 Topic 6: Infection, immunity and forensics

Students will be assessed on their ability to:

- 1 Demonstrate knowledge and understanding of the *How Science Works* areas listed in the table on page 13 of this specification.
- 20 Describe how to determine the time of death of a mammal by examining the extent of decomposition, stage of succession, forensic entomology, body temperature and degree of muscle contraction.
- 9 Describe the role of micro-organisms in the decomposition of organic matter and the recycling of carbon.
- 5 Describe how DNA profiling is used for identification and determining genetic relationships between organisms (plants and animals).
- 6 **Describe how DNA can be amplified using the polymerase chain reaction (PCR).**
- 7 **Describe how gel electrophoresis can be used to separate DNA fragments of different length.**
- 8 Distinguish between the structure of bacteria and viruses.
- 11 Explain how bacterial and viral infectious diseases have a sequence of symptoms that may result in death, including the diseases caused by *Mycobacterium tuberculosis* (TB) and Human Immunodeficiency Virus (HIV).
- 12 Describe the non-specific responses of the body to infection, including inflammation, lysozyme action, interferon, and phagocytosis.
- 13 Explain the roles of antigens and antibodies in the body's immune response including the involvement of plasma cells, macrophages and antigen-presenting cells.
- 14 Distinguish between the roles of B cells (including B memory and B effector cells) and T cells (T helper, T killer and T memory cells) in the body's immune response.

- 3 Explain the process of protein synthesis (transcription, translation messenger RNA, transfer RNA, ribosomes and the role of start and stop codons) and explain the roles of the template (antisense) DNA strand in transcription, codons on messenger RNA, anticodons on transfer RNA.
- 2 Explain the nature of the genetic code (triplet code, non-overlapping and degenerate).
- 4 Explain how one gene can give rise to more than one protein through post-transcriptional changes to messenger RNA.
- 10 Describe the major routes pathogens may take when entering the body and explain the role of barriers in protecting the body from infection, including the roles of skin, stomach acid, gut and skin flora.
- 15 Explain how individuals may develop immunity (natural, artificial, active, passive).
- 16 Discuss how the theory of an 'evolutionary race' between pathogens and their hosts is supported by the evasion mechanisms as shown by Human Immunodeficiency Virus (HIV) and *Mycobacterium tuberculosis* (TB).
- 17 Distinguish between bacteriostatic and bactericidal antibiotics.
- 18 **Describe how to investigate the effect of different antibiotics on bacteria.**
- 19 Describe how an understanding of the contributory causes of hospital acquired infections have led to codes of practice relating to antibiotic prescription and hospital practice relating to infection prevention and control.

## 8.1 Unit description

### Topic 7: Run for your life

This topic is centred on the physiological adaptations that enable animals and humans, particularly sports people, 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.

### 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. It investigates how imbalances in brain chemicals may result in conditions such as Parkinson's disease and its treatment with drugs are investigated. Students discuss the ethical issues raised by the Human Genome Project and the risks and benefits of using genetically modified organisms.

## 8.2 Assessment information

This unit is assessed by means of a written examination paper, which carries 90 marks, lasts 1 hour 45 minutes and will include:

- objective questions
- structured questions
- short-answer questions

and will also cover:

- *How Science Works*
- practical-related questions.

One question will relate to a previously released scientific article that students will have studied during the course. Students may be asked to summarise the information in the article, and explain or comment upon the biology and other issues within the context of the article. The article may draw on knowledge and understanding from any of the four units 1, 2, 4 and 5. A different article will be provided each year and the examination questions will change to reflect this. This question carries a third of the marks of this unit.

## 8.3 Topic 7: Run for your life

**Students will be assessed on their ability to:**

- 1 Demonstrate knowledge and understanding of the *How Science Works* areas listed in the table on page 13 of this specification.
- 4 Recall the way in which muscles, tendons, the skeleton and ligaments interact to enable movement, including antagonistic muscle pairs, extensors and flexors.
- 3 Explain the contraction of skeletal muscle in terms of the sliding filament theory, including the role of actin, myosin, troponin, tropomyosin, calcium ions ( $\text{Ca}^{2+}$ ), ATP and ATPase.

- 5 Describe the overall reaction of aerobic respiration as splitting of the respiratory substrate (eg glucose) to release carbon dioxide as a waste product and reuniting of hydrogen with atmospheric oxygen with the release of a large amount of energy.
- 7 Recall how phosphorylation of ADP requires energy and how hydrolysis of ATP provides an accessible supply of energy for biological processes.
- 8 Describe the roles of glycolysis in aerobic and anaerobic respiration, including the phosphorylation of hexoses, the production of ATP, reduced coenzyme and pyruvate acid (details of intermediate stages and compounds are not required).
- 9 Describe the role of the Krebs cycle in the complete oxidation of glucose and formation of carbon dioxide (CO<sub>2</sub>), ATP, reduced NAD and reduced FAD (names of other compounds are not required) and that respiration is a many-stepped process with each step controlled and catalysed by a specific intracellular enzyme.
- 10 Describe the synthesis of ATP by oxidative phosphorylation associated with the electron transport chain in mitochondria, including the role of chemiosmosis and ATPase.
- 11 Explain the fate of lactate after a period of anaerobic respiration in animals.
- 12 Understand that cardiac muscle is myogenic and describe the normal electrical activity of the heart, including the roles of the sinoatrial node (SAN), the atrioventricular node (AVN) and the bundle of His, and how the use of electrocardiograms (ECGs) can aid the diagnosis of cardiovascular disease (CVD) and other heart conditions.

- 13 Explain how variations in ventilation and cardiac output enable rapid delivery of oxygen to tissues and the 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.
- 14 **Describe how to investigate the effects of exercise on tidal volume and breathing rate using data from spirometer traces.**
- 2 Describe the structure of a muscle fibre and explain the structural and physiological differences between fast and slow twitch muscle fibres.
- 15 Explain the principle of negative feedback in maintaining systems within narrow limits.
- 16 Discuss the concept of homeostasis and its importance in maintaining the body in a state of dynamic equilibrium during exercise, including the role of the hypothalamus and the mechanisms of thermoregulation.
- 18 Analyse and interpret data on possible disadvantages of exercising too much (wear and tear on joints, suppression of the immune system) and exercising too little (increased risk of obesity, coronary heart disease (CHD) and diabetes), recognising correlation and causal relationships.
- 19 Explain how medical technology, including the use of keyhole surgery and prostheses, is enabling those with injuries and disabilities to participate in sports, eg cruciate ligaments repair using keyhole surgery and knee joint replacement using prosthetics.
- 20 Outline two ethical positions relating to whether the use of performance-enhancing substances by athletes is acceptable.
- 17 Explain how genes can be switched on and off by DNA transcription factors including hormones.
- 6 **Describe how to investigate rate of respiration practically.**

## 8.4 Topic 8: Grey matter

Students will be assessed on their ability to:

- 1 Demonstrate knowledge and understanding of the *How Science Works* areas listed in the table on page 13 of this specification.
- 3 Describe the structure and function of sensory, relay and motor neurones including the role of Schwann cells and myelination.
- 7 Explain how the nervous systems of organisms can cause effectors to respond as exemplified by pupil dilation and contraction.
- 4 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.
- 2 Describe how plants detect light using photoreceptors and how they respond to environmental cues.
- 5 Describe the structure and function of synapses, including the role of neurotransmitters, such as acetylcholine.
- 6 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, sodium ions, cation channels and hyperpolarisation of rod cells in forming action potentials in the optic neurones.
- 8 Compare mechanisms of coordination in plants and animals, ie nervous and hormonal, including the role of IAA in phototropism (details of individual mammalian hormones are not required).
- 9 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 (coordinate movement) and medulla oblongata (control the heartbeat).

- 10 Describe the use of magnetic resonance imaging (MRI), functional magnetic resonance imaging (fMRI) and computed tomography (CT) scans in medical diagnosis and investigating brain structure and function.
- 11 Discuss whether 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.
- 14 Describe how animals, including humans, can learn by habituation.
- 12 Describe the role animal models have played in developing explanations of human brain development and function, including Hubel and Wiesel's experiments with monkeys and kittens.
- 16 Discuss the moral and ethical issues relating to the use of animals in medical research from two ethical standpoints.
- 17 Explain how imbalances in certain, naturally occurring, brain chemicals can contribute to ill health (eg dopamine in Parkinson's disease and serotonin in depression) and to the development of new drugs.
- 18 Explain the effects of drugs on synaptic transmissions, including the use of L-Dopa in the treatment of Parkinson's disease and the action of MDMA in ecstasy.
- 19 Discuss how the outcomes of the Human Genome Project are being used in the development of new drugs and the social, moral and ethical issues this raises.
- 20 Describe how drugs can be produced using genetically modified organisms (plants and animals and micro-organisms).
- 21 Discuss the risks and benefits associated with the use of genetically modified organisms.

- 13 Consider the methods used to compare the contributions of nature and nurture to brain development, including evidence from the abilities of newborn babies, animal experiments, studies of individuals with damaged brain areas, twin studies and cross-cultural studies.
- 15 **Describe how to investigate habituation to a stimulus.**



# GENERIC UNITS (CONCEPT AND CONTEXT)

**The following section contains details of the internal assessments for Units 3 and 6.  
The same internal assessments are used for both the concept-led and context-led  
approaches.**



## 9.1 Part 1: Practical biology skills

Students will further develop their practical skills, whichever approach (context or concept) has been taken. Students will carry out the recommended core practicals and other practical investigations, which will require them to work safely, produce valid results and present data in the most appropriate format.

Students will carry out practical work during the GCE Biology AS course, which will be verified by the teacher using the criteria below and submitted to Edexcel using a verification of practical skills record.

The teacher will verify students' ability to:

- a Use apparatus skilfully and safely
  - i Apparatus and materials are handled correctly and safely and manipulative techniques are used in an appropriate and safe manner.
  - ii The practical work is carried out in an organised, methodical and safe manner, with due consideration of the wellbeing of living organisms and the environment.
- b Produce and record reliable and valid results
  - i Measurements and observations are made with precision and recorded in a structured manner; variables are identified and the validity and reliability of results are justified.
  - ii Possible systematic errors and random errors in generating results are identified and explained.
- c Present and analyse data
  - i Use appropriate methods to analyse results, present data and identify trends, patterns and/or observations.
  - ii Any apparent anomalies and inconsistencies are described, the methodology is evaluated and suggestions are made to improve or further the work of the investigation.

**Edexcel reserves the right to:**

- make it a requirement that centre staff undertake appropriate training to ensure the correct application of the verification process of practical skills
- arrange a centre visit to inspect procedures for the verification of practical skills.

Other practical-related skills, including analysis and evaluation of data may be assessed in the externally assessed components.

## 9.2 Part 2: Visit or issue report

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, 3rd Edition* (Institute of Biology, 2000) ISBN 0900490365, or visit [www.iob.org](http://www.iob.org).

Edexcel will issue centres with exemplar internal assessment material for *Unit 3, Part 2: Visit or issue report*, as part of the guidance for teachers.

Re-sit opportunities are available for Unit 3, students may carry forward verification of practical skills record and re-submit a new *Visit or Issue Report*.

Students will present a written report, which will be marked by the teacher and moderated by Edexcel or externally 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 describe the biological-based methods and processes in the context of a selected problem or issue; identify the relevant applications of biology; use information or arguments from their research and communicate clearly. 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 will be marked by the teacher or externally marked by Edexcel against the assessment criteria given below. HSW relates to *How Science Works* (see page 13). Centres requesting moderation of students' work will be required to submit marks and moderation sample by mid-May. Edexcel-marked reports will be required to be submitted to an examiner appointed by Edexcel by mid-May. Further guidance for submission of student work and marks will be published in the Edexcel Information Manual.

Work selected for moderation must be submitted electronically to Edexcel.

9.3 Assessment criteria

Assessment criteria	Level of response	Mark range
1 Describe the biological methods and processes used in a chosen area of biology in the context of a problem or question identified during a visit made or issue researched (HSW 1, 2, 6)	Identify and describe a question or problem in an area of biology relevant to a visit made or issue researched.	0–4 marks
	Describe the biological methods and processes involved in producing data or solutions to problems or questions relevant to a visit made or issue researched.	0–4 marks
	Explain how the methods and processes used in the chosen area of biology are appropriate in terms of producing both valid and reliable data or effective solutions to address the problem or question identified using graphs, photos, diagrams and tables that are appropriate, relevant and integrated with the report.	0–4 marks
2 Identify applications and implications of the biology encountered within the context of the visit or issue researched (HSW 9, 10)	Identify two implications (ethical, social, economic or environmental) of the applied biology encountered within the context of the visit or issue researched.	0–4 marks
	Evaluate benefits and risks to humans, other organisms and the environment as appropriate of the implications of the applied biology being studied identified.	0–4 marks
	Discuss alternative views or solutions for implications of the biology encountered within the context of the visit or issue.	0–4 marks
3 Use information or arguments obtained from three or more sources (including at least one web-based and one not web-based) when researching the visit or issue (HSW 8, 11)	Use information or arguments obtained from three or more sources (including at least one web-based and one not web-based) when researching the visit or issue. Clearly identify any quotes from sources.	0–4 marks
	Provide information about the source, author and date of three or more references used in the visit or issue report. Link references to the appropriate text in the visit or issue report.	0–4 marks
	Evaluate at least two references used in the report.	0–4 marks
4 Communicate clearly, concisely and logically with appropriate use of visuals (HSW 8)	Spelling, punctuation and grammar are correct, and the presentation is logical and concise. There is good use of technical language. Visuals are present, but not necessarily referred to in the text.	0–4 marks
<b>TOTAL NUMBER OF MARKS AVAILABLE</b>		<b>40</b>

## 9.4 Organisation of the visit

The visit may take a variety of forms, provided it gives students an opportunity to meet the assessment criteria given above; 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 report. 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.

## 9.5 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 issue(s) chosen.

The report must show evidence sought from a range of sources and be targeted to a named 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.

**Responsibility**

The responsibility for undertaking a visit, or researching an issue, lies with the centre, not Edexcel.

**9.6 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.

Illustrations might include computer-generated artwork, 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 40 marks against the assessment criteria. 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.

Students should clearly identify the 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.



## 10.1 Practical biology and investigative skills

The requirements at A2 level require further progression by the student as evidenced by the submission of an individual investigation in Unit 6.

Teachers should make the practical and investigative skills criteria available to students to enable them to understand what is expected of them.

Students will further develop their practical skills, whichever approach (context or concept) has been taken. Students will carry out the recommended core practicals in Units 4 and 5 and their individual investigations.

Students will carry out practical work during the GCE Biology A2 course, which will be verified by the teacher using the criteria below and submitted to Edexcel using a verification of practical skills record.

The teacher will verify student's ability to:

- a Use apparatus skilfully and safely
  - i Apparatus and materials are handled correctly and safely and manipulative techniques are used in an appropriate and safe manner.
  - ii The practical work is carried out in an organised, methodical and safe manner, with due consideration of the wellbeing of living organisms and the environment.
- b Produce and record reliable and valid results
  - i Measurements and observations are made with precision and recorded in a structured manner; variables are identified and the validity and reliability of results are justified.
  - ii Possible systematic errors and random errors in generating results are identified and explained.
- c Present and analyse data
  - i Use appropriate methods to analyse results, present data and identify trends, patterns and/or observations.
  - ii Any apparent anomalies and inconsistencies are described, the methodology is evaluated and suggestions are made to improve or further the work of the investigation.

Other practical-related skills, including analysis and evaluation of data may be assessed in the externally assessed components.

**Edexcel reserves the right to:**

- make it a requirement that centre staff undertake appropriate training to ensure the correct application of the verification process of practical skills
- arrange a centre visit to inspect procedures for the verification of practical skills.

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, 3rd Edition* (Institute of Biology, 2000) ISBN 0900490365.

Edexcel will issue centres with exemplar practical assessment material for Unit 6, Individual Investigation.

## 10.2 Part 2: Individual investigation (45 marks)

Students will present a written report, of an experimental investigation they have devised and carried out. The Individual Investigation in Unit 6 is an individual practical project, which is designed to show progression from the internal assessment in the AS course.

Each student is required to carry out an extended practical project. It is suggested that it takes 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.

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 of their investigations. Teachers may offer general guidance without penalty. 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 electronically. This report will be marked by the teacher and the reports from selected students will be inspected by a moderator appointed by Edexcel, or alternatively the reports can be externally marked 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.

### 10.3 Organisation

Investigations must be linked to the content of the course, and have the potential to allow students to meet all the assessment criteria given on page 92.

There are a number of suggested topics for investigation, and students can select one of these. (For further information, please see *Further resources* on page 151.) However, the choice should not be restricted to these topics. Students may wish to suggest their own topics for investigation.

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.

## 10.4 Preparation

Students should do some background research for their individual 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 worldwide web. 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.

## 10.5 Experimentation

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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.

## 10.6 The report

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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 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.

Credit will be given to reports that are clear and concise, show good use of English and appropriate biological terminology.

The investigation is marked out of a total of 45 marks, using the criteria given below.

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 in internal assessment of students, centres must make arrangements for internal moderation to be carried out, and details of this procedure must be available for the 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.

## 10.7 Assessment criteria for the individual investigation

Assessment criteria	Level of response	Mark range
<b>Research and rationale</b>	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.	0–2 marks
	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.	
	a There is a partial rationale for the choice of investigation. The biological background to the investigation is developed to some extent.	3–6 marks
	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.	
	a The rationale for the investigation is clear, in terms of its scope and relationship to biological principles.	7–9 marks
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.		
a The rationale for the investigation is clearly justified in terms of its scope and appropriate biological principles are discussed.	10–11 marks	
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.		

Assessment criteria	Level of response	Mark range
<b>Planning</b>	a There is some attempt to plan and to select the method or apparatus chosen. Some relevant variables are identified. b Some potential safety hazards and the steps to avoid or minimise them are identified. c A trial experiment may be carried out.	0–2 marks
	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. b Most potential safety hazards, and the steps to avoid or minimise them, are identified. c A trial experiment is performed that has some bearing on the planning of the project.	3–6 marks
	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. b All potential safety hazards are identified, and suitable steps taken to avoid or minimise them. 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.	7–9 marks
	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.	10–11 marks

Assessment criteria	Level of response	Mark range
<b>Observing and recording</b>	a Some appropriate measurements and observations are recorded, which are adequate for the method used and reasonably accurate. b There is some repeating or checking of values obtained.	0–2 marks
	a Measurements and observations are recorded methodically and accurately in appropriate units, and some thought is given to precision and repeatability. 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.	3–6 marks
	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. 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 is reliable.	7–8 marks
<b>Interpreting and evaluation</b>	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. b There is an attempt to apply biological principles. c Some conclusions are stated. There is some awareness of the limitations of experimental results and conclusions.	0–3 marks
	a Data is 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. b Some attempt is made to interpret results using biological principles, and to draw conclusions based on experimental results. c Conclusions are supported by results. The limitations of results, and conclusions based upon them, are recognised. Any limitations of methods are recognised.	4–6 marks
	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. b Results are interpreted using biological principles and concepts of Advanced GCE standard. Relevant biological principles are applied correctly throughout. 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.	7–9 marks

Assessment criteria	Level of response	Mark range
<b>Communicating</b>	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. b Data is presented in graphs, tables or diagrams, which are mostly appropriate and follow scientific conventions for presentation. c Spelling, punctuation and grammar are generally correct, some technical terms are used appropriately and most sources used are acknowledged in a bibliography. d Sources include at least one professional scientific journal.	0–2 marks
	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. b Data is presented in well-chosen graphs, tables or diagrams, which usually follow scientific conventions and mostly use SI units, where appropriate, correctly. c Spelling, punctuation and grammar are correct, appropriate technical terms are used throughout. Sources are selected and used appropriately and are correctly and clearly referenced within a properly constructed bibliography. d There is some discussion of the credibility of sources used.	3–4 marks
	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. b Data is presented effectively in graphs, tables or diagrams that follow scientific conventions and are clearly and accurately labelled using SI units where appropriate. c Spelling, punctuation and grammar are correct, and appropriate technical terms are used throughout. d Sources used are evaluated with reference to their credibility within the wider scientific community.	5–6 marks
<b>TOTAL NUMBER OF MARKS AVAILABLE</b>		<b>45</b>

## Administration of internal assessment

**1 Internal standardisation** Teachers choosing the option of marking the internal assessment work themselves must show clearly how the marks have been awarded in relation to the assessment criteria. If more than one teacher in a centre is marking students' work, there must be a process of internal standardisation to ensure that there is consistent application of the assessment criteria.

**2 Authentication** All candidates must sign an authentication statement. Statements relating to work not sampled should be held securely in your centre. Those which relate to sampled candidates must be attached to the work and sent to the moderator. In accordance with a revision to the current Code of Practice, any candidate unable to provide an authentication statement will receive zero credit for the component. Where credit has been awarded by a teacher to sampled work without an accompanying authentication statement, the moderator will inform Edexcel and the mark will be adjusted to zero.

**3 Further information** Centres requesting moderation of students' work will be required to submit marks and moderation sample by mid-May. Edexcel-marked reports will be required to be submitted to an examiner appointed by Edexcel by mid-May. Further guidance for submission of student work and marks will be published in the Edexcel Information Manual.

For more information on annotation, authentication, mark submission and moderation procedures, please refer to the *Edexcel AS and GCE in Biology: Instructions and administrative documentation for internally assessed units* document, which is available on the Edexcel website.

For up-to-date advice on teacher involvement, please refer to the Joint Council for Qualifications (JCQ) *Instructions for conducting coursework/portfolio* document on the JCQ website: [www.jcq.org.uk](http://www.jcq.org.uk). For up-to-date advice on malpractice and plagiarism, please refer to the Joint Council for Qualifications (JCQ) *Suspected Malpractice in Examinations: Policies and Procedures* and *Instructions for conducting coursework/portfolio* documents on the JCQ website ([www.jcq.org.uk](http://www.jcq.org.uk)).

## D Assessment and additional information

### Assessment information

<b>Assessment requirements</b>	For a summary of assessment requirements and assessment objectives, see <i>Section B, Specification overview</i> .
<b>Entering candidates for the examinations for this qualification</b>	Details of how to enter candidates for the examinations for this qualification can be found in Edexcel's <i>Information Manual</i> , copies of which are sent to all examinations officers. The information can also be found on Edexcel's website ( <a href="http://www.edexcel.com">www.edexcel.com</a> ).
<b>Resitting of units</b>	<p>There is no limit to the number of times that a student may retake a unit prior to claiming certification for the qualification. The best available result for each contributing unit will count towards the final grade.</p> <p>After certification all unit results may be reused to count towards a new award. Students may re-enter for certification only if they have retaken at least one unit.</p> <p>Results of units held in the Edexcel unit bank have a shelf life limited only by the shelf life of this specification.</p>
<b>Awarding and reporting</b>	<p>The grading, awarding and certification of this qualification will comply with the requirements of the current GCSE/GCE Code of Practice, which is published by the Office of Qualifications and Examinations Regulation (Ofqual). The AS qualification will be graded and certificated on a five-grade scale from A to E. The full GCE Advanced level will be graded on a six-point scale A* to E. Individual unit results will be reported.</p> <p>A pass in an Advanced Subsidiary subject is indicated by one of the five grades A, B, C, D, E of which grade A is the highest and grade E the lowest. A pass in an Advanced GCE subject is indicated by one of the six grades A*, A, B, C, D, E of which Grade A* is the highest and Grade E the lowest. To be awarded an A* students will need to achieve an A on the full GCE Advanced level qualification and an A* aggregate of the A2 units. Students whose level of achievement is below the minimum judged by Edexcel to be of sufficient standard to be recorded on a certificate will receive an unclassified U result.</p>

### Performance descriptions

Performance descriptions give the minimum acceptable level for a grade. See *Appendix 1* for the performance descriptions for this subject.

### Unit results

The minimum uniform marks required for each grade for each unit:

#### Unit 1

Unit grade	A	B	C	D	E
Maximum uniform mark = 120	96	84	72	60	48

Students who do not achieve the standard required for a grade E will receive a uniform mark in the range 0–47.

#### Unit 2

Unit grade	A	B	C	D	E
Maximum uniform mark = 120	96	84	72	60	48

Students who do not achieve the standard required for a grade E will receive a uniform mark in the range 0–47.

#### Unit 3

Unit grade	A	B	C	D	E
Maximum uniform mark = 60	48	42	36	30	24

Students who do not achieve the standard required for a grade E will receive a uniform mark in the range 0–23.

#### Unit 4

Unit grade	A	B	C	D	E
Maximum uniform mark = 120	96	84	72	60	48

Students who do not achieve the standard required for a grade E will receive a uniform mark in the range 0–47.

**Unit 5**

Unit grade	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>
Maximum uniform mark = 120	<b>96</b>	<b>84</b>	<b>72</b>	<b>60</b>	<b>48</b>

Students who do not achieve the standard required for a grade E will receive a uniform mark in the range 0–47.

**Unit 6**

Unit grade	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>
Maximum uniform mark = 60	<b>48</b>	<b>42</b>	<b>36</b>	<b>30</b>	<b>24</b>

Students who do not achieve the standard required for a grade E will receive a uniform mark in the range 0–23.

**Qualification results**

The minimum uniform marks required for each grade:

**Advanced Subsidiary Cash-in code 8BI01**

Qualification grade	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>
Maximum uniform mark = 300	<b>240</b>	<b>210</b>	<b>180</b>	<b>150</b>	<b>120</b>

Candidates who do not achieve the standard required for a grade E will receive a uniform mark in the range 0–119.

**Advanced GCE Cash-in code 9BI01**

Qualification grade	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>
Maximum uniform mark = 600	<b>480</b>	<b>420</b>	<b>360</b>	<b>300</b>	<b>240</b>

Candidates who do not achieve the standard required for a grade E will receive a uniform mark in the range 0–239.

**Language of assessment**

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

### Quality of written communication

Students will be assessed on their ability to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise relevant information clearly and coherently, using specialist vocabulary when appropriate.

### Assessment objectives and weighting

		% in AS	% in A2	% in GCE
<b>A01</b>	Knowledge and understanding of science and of <i>How Science Works</i>	30–34%	26–30%	30–34%
<b>A02</b>	Application of knowledge and understanding of science and of <i>How Science Works</i>	34–40%	42–48%	38–44%
<b>A03</b>	How Science Works	28%	26%	27%
	<b>Total</b>	100%	100%	100%

### Synoptic assessment

In synoptic assessment there should be a concentration on the quality of assessment to ensure that it encourages the development of the holistic understanding of the subject.

Synopticity requires students to connect knowledge, understanding and skills acquired in different parts of the Advanced GCE course.

Synoptic assessment in the external Units 4 and 5 may draw on AS material.

### Stretch and challenge

Students can be stretched and challenged in Units 4 and 5 through the use of different assessment strategies, for example:

- using a variety of stems in questions – for example analyse, evaluate, discuss, compare
- ensuring connectivity between sections of questions (synopticity)
- a requirement for extending writing
- use of a wider range of question types to address different skills – for example open-ended questions, case studies, etc.

## Additional information

### Malpractice and plagiarism

For up-to-date advice on malpractice and plagiarism, please refer to the latest *Joint Council for Qualifications (JCQ) Instructions for Conducting Coursework* document. This document is available on the JCQ website: [www.jcq.org.uk](http://www.jcq.org.uk).

For additional information on malpractice, please refer to the latest *Joint Council for Qualifications (JCQ) Suspected Malpractice in Examinations And Assessments: Policies and Procedures* document, available on the JCQ website.

### Access arrangements and special requirements

Edexcel's policy on access arrangements and special considerations for GCE, GCSE, and Entry Level is designed to ensure equal access to qualifications for all students (in compliance with the Equality Act 2010) without compromising the assessment of skills, knowledge, understanding or competence.

Please see the Joint Council for Qualifications (JCQ) website ([www.jcq.org.uk](http://www.jcq.org.uk)) for their policy on access arrangements, reasonable adjustments and special considerations.

Please see our website ([www.edexcel.com](http://www.edexcel.com)) for:

- the forms to submit for requests for access arrangements and special considerations
- dates to submit the forms.

Requests for access arrangements and special considerations must be addressed to:

Special Requirements  
Edexcel  
One90 High Holborn  
London WC1V 7BH

### Equality Act 2010

Please see our website ([www.edexcel.com](http://www.edexcel.com)) for information on the Equality Act 2010.

### Prior learning and progression

#### Prior learning

Students who would benefit most from studying a GCE in Biology are likely to have a Level 2 qualification such as a GCSE in Biology at grades A\*–C or equivalent, such as:

- GCSE in Additional Science at grades A\*–C
- GCSE in Applied Science (Double Award) at grades A\*–C
- GCSE in Additional Applied Science at grades A\*–C
- BTEC First Certificate in Applied Science.

#### Progression

This qualification supports progression into further education, training or employment, such as a Foundation Degree, Honours Degree, Higher National Diploma in biology-related subjects, or into training or employment.

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### Combinations of entry

There are no forbidden combinations.

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### Student recruitment

Edexcel's access policy concerning recruitment to our qualifications is that:

- they must be available to anyone who is capable of reaching the required standard
- they must be free from barriers that restrict access and progression
- equal opportunities exist for all students.

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### The wider curriculum

This qualification provides opportunities for developing an understanding of moral, ethical, social and cultural issues, together with an awareness of citizenship, environmental issues, health and safety considerations, and European developments consistent with relevant international agreements appropriate as applied to biology. *Appendix 4: Wider curriculum* maps the opportunities available.

# E Resources, support and training

## Resources to support the specification

In addition to the resources available in the *Getting Started* and *Internal Assessment* guide books, Edexcel produces a wide range of resources to support this specification.

## Edexcel's own published resources

Edexcel aims to provide the most comprehensive support for our qualifications. We have therefore published our own dedicated suite of resources for teachers and students written by qualification experts.

The resources for the concept approach include:

- AS Students' Book
- A2 Students' Book
- AS ActiveTeach CD ROM
- A2 ActiveTeach CD ROM
- AS Teacher Support Pack
- A2 Teacher Support Pack.

The resources for the context approach include:

- AS Students' Book
- A2 Students' Book
- AS student website
- A2 student website.

For more information on our complete range of products and services for GCE in Biology, visit [www.edexcel.com/gce2008](http://www.edexcel.com/gce2008).

### Edexcel publications

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You can order further copies of the specification and sample assessment materials (SAMs) documents from:

Edexcel Publications  
Adamsway  
Mansfield  
Nottinghamshire  
NG18 4FN

Telephone: 01623 467467  
Fax: 01623 450481  
Email: [publication.orders@edexcel.com](mailto:publication.orders@edexcel.com)  
Website: [www.edexcel.com](http://www.edexcel.com)

### Additional resources endorsed by Edexcel

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Edexcel also endorses additional materials written to support this qualification.

Any resources bearing the 'Endorsed by Edexcel' logo have been through a rigorous quality assurance process to ensure complete and accurate support for the specification. For up-to-date information about endorsed resources, please visit [www.edexcel.com/endorsed](http://www.edexcel.com/endorsed)

Please note that while resources are checked at the time of publication, materials may be withdrawn from circulation and website locations may change.

The resources on the Edexcel website are intended to be a guide for teachers and not a comprehensive list. Further suggestions can be found in *Appendix 6: Further resources and support*.

Please see [www.edexcel.com/gce2008](http://www.edexcel.com/gce2008) for up-to-date information.

## Support from the University of York Science Education Group (UYSEG)

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The Salters-Nuffield Advanced Biology project team of the University of York Science Education Group runs in-service courses for teachers and technicians from centres that are following, or preparing to follow, this GCE Biology specification.

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 Education Group  
Alcuin College  
University of York  
Heslington  
York  
YO10 5DD

Telephone: 01904 432601  
Email: jm47@york.ac.uk

The Salters-Nuffield Advanced Biology website contains some general information about the project:

[www.advancedbiology.org](http://www.advancedbiology.org)

Enquiries concerning assessment and administration should be addressed to the Qualifications and Delivery and Awards Manager for Biology at Edexcel.

## Edexcel support services

### Edexcel support services

**ResultsPlus** – ResultsPlus is an application launched by Edexcel to help subject teachers, senior management teams, and students by providing detailed analysis of examination performance. Reports that compare performance between subjects, classes, your centre and similar centres can be generated in 'one-click'. Skills maps that show performance according to the specification topic being tested are available for some subjects. For further information about which subjects will be analysed through ResultsPlus, and for information on how to access and use the service, please visit [www.edexcel.com/resultsplus](http://www.edexcel.com/resultsplus)

**Ask the Expert** – to make it easier for our teachers to ask us subject specific questions we have provided the **Ask the Expert** Service. This easy-to-use web query form will allow you to ask any question about the delivery or teaching of Edexcel qualifications. You'll get a personal response, from one of our administrative or teaching experts, sent to the email address you provide. You can access this service at [www.edexcel.com/ask](http://www.edexcel.com/ask)

### Support for Students

Learning flourishes when students take an active interest in their education; when they have all the information they need to make the right decisions about their futures. With the help of feedback from students and their teachers, we've developed a website for students that will help them:

- understand subject specifications
- access past papers and mark schemes
- learn about other students' experiences at university, on their travels and when entering the workplace.

We're committed to regularly updating and improving our online services for students. The most valuable service we can provide is helping schools and colleges unlock the potential of their learners. [www.edexcel.com/students](http://www.edexcel.com/students)

## Training

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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 can be obtained from:

Training from Edexcel  
Edexcel  
One90 High Holborn  
London WC1V 7BH

email: [trainingbookings@pearson.com](mailto:trainingbookings@pearson.com)  
Website: [www.edexcel.com/training](http://www.edexcel.com/training)



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## Introduction

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Performance descriptions have been created for all GCE subjects. They describe the learning outcomes and levels of attainment likely to be demonstrated by a representative candidate performing at the A/B and E/U boundaries for AS and A2.

In practice most candidates will show uneven profiles across the attainments listed, with strengths in some areas compensating in the award process for weaknesses or omissions elsewhere. Performance descriptions illustrate expectations at the A/B and E/U boundaries of the AS and A2 as a whole; they have not been written at unit level.

Grade A/B and E/U boundaries should be set using professional judgement. The judgement should reflect the quality of candidates' work, informed by the available technical and statistical evidence. Performance descriptions are designed to assist examiners in exercising their professional judgement. They should be interpreted and applied in the context of individual specifications and their associated units. However, performance descriptions are not designed to define the content of specifications and units.

The requirement for all AS and A level specifications to assess candidates' quality of written communication will be met through one or more of the assessment objectives.

The performance descriptions have been produced by the regulatory authorities in collaboration with the awarding bodies.

AS performance descriptions for Biology

Assessment objectives	Assessment objective 1 <b>Knowledge and understanding of science and of How science works</b> Candidates should be able to: <ul style="list-style-type: none"> <li>■ recognise, recall and show understanding of scientific knowledge</li> <li>■ select, organise and communicate relevant information in a variety of forms.</li> </ul>	Assessment objective 2 <b>Application of knowledge and understanding of science and of How science works</b> Candidates should be able to: <ul style="list-style-type: none"> <li>■ analyse and evaluate scientific knowledge and processes</li> <li>■ apply scientific knowledge and processes to unfamiliar situations including those related to issues</li> <li>■ assess the validity, reliability and credibility of scientific information.</li> </ul>	Assessment objective 3 <b>How science works</b> Candidates should be able to: <ul style="list-style-type: none"> <li>■ demonstrate and describe ethical, safe and skilful practical techniques and processes, selecting appropriate qualitative and quantitative methods</li> <li>■ make, record and communicate reliable and valid observations and measurements with appropriate precision and accuracy</li> <li>■ analyse, interpret, explain and evaluate the methodology, results and impact of their own and others' experimental and investigative activities in a variety of ways.</li> </ul>
<b>A/B boundary performance descriptions</b>	<p>Candidates characteristically:</p> <ul style="list-style-type: none"> <li>a demonstrate knowledge and understanding of most principles, concepts and facts from the AS specification</li> <li>b select relevant information from the AS specification</li> <li>c organise and present information clearly in appropriate forms using scientific terminology.</li> </ul>	<p>Candidates characteristically:</p> <ul style="list-style-type: none"> <li>a apply principles and concepts in familiar and new contexts involving only a few steps in the argument</li> <li>b describe significant trends and patterns shown by data presented in tabular or graphical form; interpret phenomena with few errors; and present arguments and evaluations clearly</li> <li>c comment critically on statements, conclusions or data</li> <li>d carry out accurately most of the calculations specified for AS</li> <li>e translate successfully data that is presented as prose, diagrams, drawings, tables or graphs from one form to another.</li> </ul>	<p>Candidates characteristically:</p> <ul style="list-style-type: none"> <li>a devise and plan experimental and investigative activities, selecting appropriate techniques</li> <li>b demonstrate safe and skilful practical techniques and comment effectively on ethical issues</li> <li>c make observations and measurements with appropriate precision and record them methodically</li> <li>d interpret, explain, evaluate and communicate the results of their own and others' experimental and investigative activities, in appropriate contexts.</li> </ul>

<b>E/U boundary performance descriptions</b>	<b>Assessment objective 1</b> Candidates characteristically: a demonstrate knowledge and understanding of some principles and facts from the AS specification b select some relevant information from the AS specification c present information using basic terminology from the AS specification.	<b>Assessment objective 2</b> Candidates characteristically: a apply a given principle to material presented in familiar or closely related contexts involving only a few steps in the argument b describe some trends or patterns shown by data presented in tabular or graphical form c identify, when directed, inconsistencies in conclusions or data d carry out some steps within calculations e translate data successfully from one form to another, in some contexts.	<b>Assessment objective 3</b> Candidates characteristically: a devise and plan some aspects of experimental and investigative activities b demonstrate safe practical techniques and comment on ethical issues c make observations and measurements and record them d interpret, explain and communicate some aspects of the results of their own and others' experimental and investigative activities, in appropriate contexts.

A2 performance descriptions for Biology

Assessment objectives	Assessment objective 1 <b>Knowledge and understanding of science and of How science works</b> Candidates should be able to: <ul style="list-style-type: none"> <li>■ recognise, recall and show understanding of scientific knowledge</li> <li>■ select, organise and communicate relevant information in a variety of forms.</li> </ul>	Assessment objective 2 <b>Application of knowledge and understanding of science and of How science works</b> Candidates should be able to: <ul style="list-style-type: none"> <li>■ analyse and evaluate scientific knowledge and processes</li> <li>■ apply scientific knowledge and processes to unfamiliar situations including those related to issues</li> <li>■ assess the validity, reliability and credibility of scientific information.</li> </ul>	Assessment objective 3 <b>How science works</b> Candidates should be able to: <ul style="list-style-type: none"> <li>■ demonstrate and describe ethical, safe and skilful practical techniques and processes, selecting appropriate qualitative and quantitative methods</li> <li>■ make, record and communicate reliable and valid observations and measurements with appropriate precision and accuracy</li> <li>■ analyse, interpret, explain and evaluate the methodology, results and impact of their own and others' experimental and investigative activities in a variety of ways.</li> </ul>
<b>A/B boundary performance descriptions</b>	<p>Candidates characteristically:</p> <ul style="list-style-type: none"> <li>a demonstrate detailed knowledge and understanding of most principles, concepts and facts from the A2 specification</li> <li>b select relevant information from the A2 specification</li> <li>c organise and present information clearly in appropriate forms using scientific terminology.</li> </ul>	<p>Candidates characteristically:</p> <ul style="list-style-type: none"> <li>a apply principles and concepts in familiar and new contexts involving several steps in the argument</li> <li>b describe significant trends and patterns shown by complex data presented in tabular or graphical form; interpret phenomena with few errors; and present arguments and evaluations clearly</li> <li>c evaluate critically any statements, conclusions or data</li> <li>d carry out accurately most of the calculations specified for A2; and apply the principles of statistical analysis when directed</li> <li>e translate successfully data that is presented as prose, diagrams, drawings, tables or graphs from one form to another</li> <li>f select a wide range of facts, principles and concepts from both AS and A2 specifications</li> <li>g link together appropriate facts principles and concepts from different areas of the specification.</li> </ul>	<p>Candidates characteristically:</p> <ul style="list-style-type: none"> <li>a devise and plan experimental and investigative activities, selecting appropriate techniques</li> <li>b demonstrate safe and skilful practical techniques and comment effectively on ethical issues</li> <li>c make observations and measurements with appropriate precision and record these methodically</li> <li>d interpret, explain, evaluate and communicate the results of their own and others' experimental and investigative activities, in appropriate contexts</li> <li>e use an appropriate statistical technique to assess the validity of a hypothesis.</li> </ul>

<b>E/U boundary performance descriptions</b>	<b>Assessment objective 1</b> Candidates characteristically: a demonstrate knowledge and understanding of some principles, concepts and facts from the A2 specification b select some relevant information from the A2 specification c present information using basic terminology from the A2 specification.	<b>Assessment objective 2</b> Candidates characteristically: a apply given principles or concepts in familiar and new contexts involving a few steps in the argument b describe, and provide a limited explanation of, trends or patterns shown by complex data presented in tabular or graphical form c identify, when directed, inconsistencies in conclusions or data d carry out some steps within calculations e translate data successfully from one form to another, in some contexts f select some facts, principles and concepts from both AS and A2 specifications g put together some facts, principles and concepts from different areas of the specification.	<b>Assessment objective 3</b> Candidates characteristically: a devise and plan some aspects of experimental and investigative activities b demonstrate safe practical techniques and comment on ethical issues c make observations and measurements and record them d interpret, explain and communicate some of the results of their own and others' experimental and investigative activities, in appropriate contexts e use a given statistical technique.



**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. It is reasonable to expect that if a student is explaining something they are also able to describe it.

**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 that 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**

Describe and 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.

In answers requiring the use of more than one word technical terms should be given in a correct biological context.



## How Science Works mapped to learning outcomes

The first learning outcome of all topics map to the *How Science Works* statement 1, ie Unit 1, Topic 1, learning outcome 1 (represented as 1.1.1); 1.2.1; 2.3.1; 2.4.1; 4.5.1; 4.6.1; 5.6.1 and 5.7.1. In addition, the *How Science Works* statements map to the following learning outcomes:

How Science Works statement	Unit	Topic	Learning outcome(s)
1 Use theories, models and ideas to develop and modify scientific explanations.	1	2	2
	4	5	19
	4	6	16
	5	8	12
2 Use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas.	1	1	9
	1	1	16
	1	2	5
	1	2	9
	2	3	7
	2	3	12
	2	4	7
	2	4	8
	2	4	9
	Unit 3		
	4	5	11
	4	5	17
	4	6	6
	4	6	7
	4	6	18
	5	7	6
	5	7	14
	5	8	15
	Unit 6		

## Appendix 3 How Science Works mapping

How Science Works statement	Unit	Topic	Learning outcome(s)	
3 Use appropriate methodology, including ICT, to answer scientific questions and solve scientific problems.	1	1	9	
	1	1	16	
	1	2	5	
	1	2	9	
	2	3	7	
	2	3	12	
	2	4	7	
	2	4	8	
	2	4	9	
	Unit 3			
	4	5	11	
	4	5	17	
	4	6	6	
	4	6	7	
	4	6	18	
	5	7	6	
	5	7	14	
	5	8	15	
	Unit 6			

How Science Works statement	Unit	Topic	Learning outcome(s)	
4 Carry out experimental and investigative activities, including appropriate risk management, in a range of contexts.	1	1	9	
	1	1	16	
	1	2	5	
	1	2	9	
	2	3	7	
	2	3	12	
	2	4	7	
	2	4	8	
	2	4	9	
	Unit 3			
	4	5	11	
	4	5	17	
	4	6	6	
	4	6	7	
	4	6	18	
	5	7	6	
	5	7	14	
	5	8	15	
	Unit 6			

## Appendix 3 How Science Works mapping

How Science Works statement	Unit	Topic	Learning outcome(s)
5 Analyse and interpret data to provide evidence, recognising correlations and causal relationships.	1	1	9
	1	1	14
	1	1	16
	1	1	17
	1	1	18
	1	2	5
	1	2	9
	2	3	7
	2	3	12
	2	4	7
	2	4	8
	2	4	9
	4	5	11
	4	5	17
	4	5	18
	4	6	6
	4	6	7
	4	6	18
	5	7	6
	5	7	14
5	7	18	
5	8	15	
6 Evaluate methodology, evidence and data, and resolve conflicting evidence.	1	1	19
	2	3	12
	5	7	6
	5	8	13
	5	8	15
7 Appreciate the tentative nature of scientific knowledge.	1	2	11
	2	3	14
	4	5	19
	5	8	11

How Science Works statement	Unit	Topic	Learning outcome(s)	
8 Communicate information and ideas in appropriate ways using appropriate terminology.	1	1	9	
	1	1	16	
	1	2	5	
	1	2	9	
	2	3	7	
	2	3	12	
	2	4	7	
	2	4	8	
	2	4	9	
	Unit 3			
	4	5	11	
	4	5	17	
	4	6	6	
	4	6	7	
	4	6	18	
	5	7	6	
	5	7	14	
	5	8	15	
	Unit 6			
9 Consider applications and implications of science and appreciate their associated benefits and risks.	1	1	13	
	1	1	20	
	1	2	19	
	4	5	9	
	5	8	21	
10 Consider ethical issues in the treatment of humans, other organisms and the environment.	1	1	9	
	1	2	20	
	5	7	20	
	5	8	15	
	5	8	16	
11 Appreciate the role of the scientific community in validating new knowledge and ensuring integrity.	1	2	11	
	2	4	14	
	4	5	23	

## Appendix 3 How Science Works mapping

How Science Works statement	Unit	Topic	Learning outcome(s)
12 Appreciate the ways in which society uses science to inform decision making.	1	1	15
	2	3	11
	4	5	20
	4	6	19

Learning outcomes mapped to *How Science Works*

AS unit	Topic	Learning outcome	How Science Works statement(s)	A2 unit	Topic	Learning outcome	How Science Works statement(s)		
1	1	1	4; 5	4	5	1	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12		
		9	2; 3; 4; 5; 8; 10			9	9		
		13	9			11	2; 3; 4; 5; 8		
		14	5			17	2; 3; 4; 5; 8		
		15	12			18	5		
		16	2; 3; 4; 5; 8			19	1; 7		
		17	5			20	12		
		18	5			23	11		
		19	6			6	1	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12	
		20	9				6	2; 3; 4; 5; 8	
	2	1	1		4; 5		7	2; 3; 4; 5; 8	
			2		1		16	1	
			5		2; 3; 4; 5; 8		18	2; 3; 4; 5; 8	
			9		2; 3; 4; 5; 8		19	12	
			11		7; 11		7	1	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12
			20		10			6	2; 3; 4; 5; 6; 8
	2	3	1		4; 5			14	2; 3; 4; 5; 8
			7		2; 3; 4; 5; 8			18	5
			11		12	20		10	
			12		2; 3; 4; 5; 6; 8	8		1	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12
14			7	11	7				
4		1	4; 5	12	1				
		7	2; 3; 4; 5; 8	13	6				
		8	2; 3; 4; 5; 8	15	2; 3; 4; 5; 6; 8; 10				
		9	2; 3; 4; 5; 8	16	10				
		14	11	21	9				
Unit 3			2; 3; 4; 8	Unit 6			2; 3; 4; 8		



## Signposting

Issue	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
Moral	✓	✓	✓	✓	✓	✓
Ethical	✓	✓	✓	✓	✓	✓
Social	✓	✓	✓	✓	✓	✓
Cultural	✓	✓	✓	✓	✓	✓
Citizenship	✓	✓	✓	✓	✓	✓
Environmental		✓	✓	✓	✓	✓
European initiatives		✓	✓	✓	✓	✓
Health and safety	✓	✓	✓	✓	✓	✓

## Development suggestions

Issue	AS/A2 units	Opportunities for development or internal assessment
Moral	1,2,3,4,5,6	<ul style="list-style-type: none"> <li>■ Discussing moral issues relating to the use of animals in experiments.</li> <li>■ Exploring moral issues arising from the Human Genome Project.</li> </ul>
Ethical	1,2,3,4,5,6	<ul style="list-style-type: none"> <li>■ Exploring ethical issues arising from the application of science as it impacts on humans, other organisms and the environment eg the use of animals in science, genetic screening for genetic conditions, the use of stem cells and the misuse of drugs in sport to enhance performance.</li> </ul>
Social	1,2,3,4,5,6	<ul style="list-style-type: none"> <li>■ Exploring biology as a human endeavour which interacts with social matters.</li> <li>■ Discussing social issues arising from, eg, gene therapy, screening for genetic conditions and the Human Genome Project.</li> </ul>
Cultural	1,2,3,4,5,6	<ul style="list-style-type: none"> <li>■ Exploring the contributions of nature and nurture to brain development using cross-cultural studies.</li> </ul>
Citizenship	1,2,3,4,5,6	<ul style="list-style-type: none"> <li>■ Discussing our role as 'stewards of the environment', eg, issues concerning global warming.</li> <li>■ Discussing how science influences decisions on an individual, local, national or international level.</li> <li>■ Exploring issues concerning sustainability.</li> <li>■ Discussing the effects of diet on personal health.</li> </ul>
Environmental	2,3,4,5,6	<ul style="list-style-type: none"> <li>■ Exploring environmental implications of biology encountered, eg, climate change and its effect on evolution, and the distribution of organisms.</li> </ul>
European initiatives	2,3,4,5,6	<ul style="list-style-type: none"> <li>■ Exploring, for example, the European Union Biodiversity Strategy</li> <li>■ Discussing seed banks.</li> </ul>
Health and safety	1,2,3,4,5,6	<ul style="list-style-type: none"> <li>■ Carrying out practical work.</li> <li>■ Using organisms safely.</li> </ul>



Type of code	Use of code	Code number
National classification codes	Every qualification is assigned to a national classification code indicating the subject area to which it belongs. 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.	1010
National Qualifications Framework (NQF) codes	Each qualification title is allocated a National Qualifications Framework (NQF) code. The National Qualifications Framework (NQF) code is known as a Qualification Number (QN). This is the code that features in the DfE Section 96, and on the LARA as being eligible for 16–18 and 19+ funding, and is to be used for all qualification funding purposes. The QN is the number that will appear on the student's final certification documentation.	The QNs for the qualifications in this publication are: AS – 500/2624/4 Advanced GCE – 500/2593/4
Unit codes	Each unit is assigned a unit code. This unit code is used as an entry code to indicate that a student wishes to take the assessment for that unit. Centres will need to use the entry codes only when entering students for their examination.	Unit 1 – 6BI01 Unit 2 – 6BI02 Unit 3 – 6BI03 Unit 4 – 6BI04 Unit 5 – 6BI05 Unit 6 – 6BI06
Cash in codes	The cash-in code is used as an entry code to aggregate the student's unit scores to obtain the overall grade for the qualification. Centres will need to use the entry codes only when entering students for their qualification.	AS – 8BI01 Advanced GCE – 9BI01
Entry codes	The entry codes are used to: 1 enter a student for the assessment of a unit 2 aggregate the student's unit scores to obtain the overall grade for the qualification.	Please refer to the <i>Edexcel Information Manual</i> , available on the Edexcel website.



Please note that while resources are checked at the time of publication, materials may be withdrawn from circulation and website locations may change at any time.

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**Books**

*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

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**Useful websites**

[www.edexcel.com/gce2008](http://www.edexcel.com/gce2008)

[www.societyofbiology.org](http://www.societyofbiology.org)

[www.snabonline.com](http://www.snabonline.com)

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**Other support**

The Salters-Nuffield Advanced Biology project team of the University of York Science Education Group runs in-service courses for teachers and technicians from centres that are following, or preparing to follow, this GCE Biology specification.

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

**Institute of Biology**

Head of Education and Training  
Institute of Biology  
9 Red Lion Court  
London EC4A 3EF

Telephone: 020 7936 5900

Website: [www.societyofbiology.org](http://www.societyofbiology.org)

**National Centre for Biotechnology Education**

The University of Reading  
Science and Technology Centre  
Earley Gate  
Reading RG6 6BZ

Telephone: 01189 873 743

Website: [www.ncbe.reading.ac.uk](http://www.ncbe.reading.ac.uk)

Email: [NCBE@reading.ac.uk](mailto:NCBE@reading.ac.uk)

**Science and Plants for Schools**

The University of Cambridge  
Homerton College  
Cambridge CB2 8PH

Telephone: 01223 507 168  
Website: [www.saps.org.uk](http://www.saps.org.uk)  
Email: [saps@homerton.cam.ac.uk](mailto:saps@homerton.cam.ac.uk)

**Wellcome Trust**

Gibbs Building  
215 Euston Road  
London NW1 2BE

Telephone: 020 7611 8888  
Website: [www.wellcome.ac.uk](http://www.wellcome.ac.uk)  
Email: [contact@wellcome.ac.uk](mailto:contact@wellcome.ac.uk)

An understanding of the following, as applied to the analysis of biological data, is expected and may be assessed in relevant units of the specification. These requirements should not be taught separately from their applications within biology; an integrated approach is expected.

1. Arithmetic and numerical computation	Recognise and use expressions in decimal and standard form.
	Use ratios, fractions and percentages.
	Make estimates of the results of calculations (without using a calculator).
	Use calculators to find and use power, exponential and logarithmic functions.
2. Handling data	Use an appropriate number of significant figures.
	Find arithmetic means.
	Construct and interpret frequency tables and diagrams, bar charts and histograms.
	Understand simple probability.
	Understand the principles of sampling as applied to scientific data.
	Understand the terms mean, median and mode.
	Use a scatter diagram to identify a correlation between two variables.
	Use a simple statistical test.
3. Algebra	Change the subject of an equation.
	Substitute numerical values into algebraic equations using appropriate units for physical quantities
4. Graphs	Translate information between graphical, numerical and algebraic forms.
	Plot two variables from experimental or other data.
	Calculate rate of change from a graph showing a linear relationship.



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