Version 1.1

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Biology / Biology (Human)

Specification A

This specification should be read in conjunction with:

Specimen and Past Papers and Mark Schemes
Examiners' Reports
Teachers' Guide

AQA ADVANCED SUBSIDIARY GCE BIOLOGY 5411
AQA ADVANCED GCE BIOLOGY 6411
AQA ADVANCED SUBSIDIARY GCE BIOLOGY (HUMAN) 5413
AQA ADVANCED GCE BIOLOGY (HUMAN) 6413

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In the Spring Term before the start of the course, details of any year-specific information, such as set texts, theme/topics, will be notified to centres in print and on the Website.

Black sidelines indicate a significant change or addition made to the specification published for 2003

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Kathleen Tattersall, Director General.

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Background Information

1 Advanced Subsidiary and Advanced Level Specifications

1.1 Advanced Subsidiary (AS)

Advanced Subsidiary courses were introduced from September 2000 for award of the first qualification in August 2001. They may be used in one of two ways:

- as a final qualification, allowing candidates to broaden their studies and to defer decisions about specialism;
- as the first half (50%) of an Advanced Level qualification, which must be completed before an Advanced Level award can be made.

Advanced Subsidiary is designed to provide an appropriate assessment of knowledge, understanding and skills expected of candidates who have completed the first half of a full Advanced Level qualification. The level of demand of the AS examination is that expected of candidates half-way through a full A Level course of study.

1.2 Advanced Level (AS+A2)

The Advanced Level examination is in two parts:

- Advanced Subsidiary (AS) – 50% of the total award;
- a second examination, called A2 – 50% of the total award.

Most Advanced Subsidiary and Advanced Level courses will be modular. The AS will comprise three teaching and learning modules and the A2 will comprise a further three teaching and learning modules. Each teaching and learning module will normally be assessed through an associated assessment unit. The specification gives details of the relationship between the modules and assessment units.

With the two-part design of Advanced Level courses, centres may devise an assessment schedule to meet their own and candidates' needs. For example:

- assessment units may be taken at stages throughout the course, at the end of each year or at the end of the total course;
- AS may be completed at the end of one year and A2 in January or June;
- AS and A2 may be completed at the end of the same year.

Details of the availability of the assessment units for each specification are provided in Section 3.

2

Specification at a Glance
Biology/Human Biology

AS Examination	
Unit 1 (Biology/Human Biology)	
1½ hours	35% of the total AS marks *17.5% of the total A Level marks*
EITHER	**OR**
Unit 2 (Biology only)	**Unit 3 (Human Biology only)**
1½ hours 35% AS *17.5% A Level*	1½ hours 35% AS *17.5% A Level*
Unit 4 (Biology/Human Biology)	
Centre-assessed Coursework	30% of the total AS marks *15% of the total A Level marks*

Advanced Subsidiary Award: 5411 (Biology), 5413 (Human Biology)

+

A2 Examination	
Unit 5 (Biology/Human Biology)	
1½ hours	15% of the total A Level marks
EITHER	OR
Unit 6 (Biology only) *(Terminal)*	**Unit 7 (Human Biology only)** *(Terminal)*
1½ hours 15% A Level *(inc. 5% synoptic)*	1½ hours 15% A Level *(inc. 5% synoptic)*
Unit 8(a) (Biology only) *(Terminal)*	**Unit 9(a) (Human Biology only)** *(Terminal)*
1¾ hours 10% A Level *(all synoptic)*	1¾ hours 10% A Level *(all synoptic)*
Unit 8(b)/9(b) (Biology/Human Biology) *(Terminal)*	
Centre-assessed Coursework	10% of the total A Level marks *(5% synoptic)*

Advanced Award: 6411 (Biology), 6413 (Human Biology)

AS Award	Advanced Level Award
Papers 1, 2, 4 (5411)	Papers 1, 2, 4, 5, 6, 8(a) and 8(b) (5411) + (6411)
Papers 1, 3, 4 (5413)	Papers 1, 3, 4, 5, 7, 9(a) and 9(b) (5413) + (6413)

Biology
Human Biology

3 Availability of Assessment Units and Entry Details

3.1 Availability of Assessment Units

Examinations based on this specification are available as follows:

	Availability of Units		Availability of Qualification	
	AS	**A2**	**AS**	**A Level**
January	all	all	✓	✓
June	all	all	✓	✓

3.2 Sequencing of Units

A Level Biology consists of Units 1, 2, 4, 5, 6 and 8a and 8b.
A Level Human Biology consists of Units 1, 3, 4, 5, 7 and 9a and 9b.

It is recommended that the units are taken in numerical order. Units 6 and 8a and 8b include the synoptic assessment of the whole A Level course, testing candidates' understanding of connections between different elements of Biology. Similarly, Units 7 and 9a and 9b are the synoptic assessment for the A Level Human Biology.

3.3 Entry Codes

Normal entry requirements apply, but the following information should be noted. The following unit entry codes should be used:

AS	**A2**
Unit 1 - *BYA1* Unit 2/3 - *BYA2 or BYA3* Unit 4 - *BYA4*	Unit 5 - *BYA5* Unit 6/7 - *BYA6 or BYA7* Unit 8 – *BYA8* consisting of *BYA8/1* (8a) and *BYA89/2* (8b) Unit 9 – *BYA9* consisting of *BYA9/1* (9a) and *BYA89/2* (9b)

The **Subject Code** for entry to the AS only award is:
5411 for Biology or
5413 for Biology (Human).

The **Subject Code** for entry to the Advanced Level is made up of the AS code plus the A2 code, i.e.
5411 plus *6411* for Biology
5413 plus *6413* for Biology (Human).

3.4 Prohibited Combinations

Candidates entering for this examination are prohibited from entering for any other GCE Biology or Human Biology specification in the same series. This does not preclude candidates taking AS and A2 units in the same specification with AQA in the same examination series.

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

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

The classification code for this specification is 1010 for Biology and 1030 for Biology (Human).

3.5 Private Candidates

This specification is not available to private candidates unless an AS/A2 award has already been made within 12 months. In which case the results for the coursework components, AS Unit 4 and/or A2 Unit 8b/9b may be carried forward, if the rest of the qualification is being retaken.

Private candidates should write to AQA for a copy *of* "*Supplementary Guidance for Private Candidates*".

3.6 Special Consideration

Special consideration may be requested for candidates whose work has been affected by illness or other exceptional circumstances. The appropriate form and all relevant information should be forwarded to the AQA office which deals with such matters for the centre concerned. Special arrangements may be provided for candidates with special needs.

Details are available from AQA. Centres should ask for a copy of "*Regulations and Guidance relating to Candidates with Particular Requirements*".

3.7 Language of Examinations

All assessment Units in this subject are provided in English only.

Scheme of Assessment

4 Introduction

This GCE Biology/Biology (Human) specification complies with:

- the Subject Criteria for Biology;
- the GCSE, GCE and VCE Code of Practice 2000/2001;
- the GCE Advanced Subsidiary and Advanced Level Qualification-Specific Criteria;
- the Arrangements for the Statutory Regulation of External Qualifications in England, Wales and Northern Ireland; Common Criteria.

AQA has developed two specifications in Biology which offer distinctive approaches to the teaching and assessment of the subject and provide continuity for centres which followed the previous syllabuses offered by AEB and NEAB.

This specification, Specification A, was modelled on the AEB syllabus and offers a Biology or Human Biology route through the AS and A Level as shown in the 'Specification at a Glance' in Section 2.

Specification B was developed from the NEAB Biology syllabus and offers optional modules (one of three) in A2 providing greater depth in specialist areas.

Prior level of attainment and recommended prior learning

This specification has been designed to be accessible to a wide range of candidates in both full and part-time education. Both Specifications A and B build on the knowledge, understanding and skills set out in the National Curriculum Key Stage 4 Programme of Study for GCSE Double Science.

Rationale

The specification provides an opportunity to gain a sound understanding of biology through the study of fundamental biological principles whilst exploring modern applications of Biology/Human Biology.

The specification provides an appropriate foundation for further study of Biology/Human Biology or related subjects in higher education. In addition it provides a worthwhile course for candidates of various ages and from diverse backgrounds in terms of general education and lifelong learning.

5 Aims

This AS and A Level specification encourages candidates to:

a. develop essential knowledge and understanding of concepts of biology, and the skills needed for the use of these in new and changing situations;

b. develop an understanding of scientific methods;

c. be aware of advances in technology, including information technology, relevant to biology;

d. recognise the value and responsible use of biology in society;

e. sustain and develop their enjoyment of, and interest in, biology.

In addition, the A Level specification encourages candidates to:

f. show knowledge and understanding of facts, principles and concepts from different areas of biology and to make and use connections between them.

6 Assessment Objectives

Assessment objectives (AOs) 1, 2 and 3 are the same for AS and A Level. AO4 applies only to the A2 part of the A Level course.

The scheme of assessment will assess candidates' ability to:

At AS and A Level

6.1 Knowledge with Understanding (AO1)

a. recognise, recall and show understanding of specific biological facts, terminology, principles, concepts and practical techniques;

b. draw on existing knowledge to show understanding of the ethical, social, economic, environmental and technological implications and applications of biology;

c. select, organise and present relevant information clearly and logically, using appropriate specialist vocabulary.

6.2 Application of knowledge and understanding, analysis, synthesis and evaluation (AO2)

a. describe, explain and interpret phenomena and effects in terms of biological principles and concepts, presenting arguments and ideas clearly and logically, using specialist vocabulary where appropriate;

b. interpret, and translate from one form into another, data presented as continuous prose, or in tables, diagrams, drawings and graphs;

c. apply biological principles and concepts in solving problems in unfamiliar situations including those which relate to the ethical, social, economic and technological implications and applications of biology;

d. assess the validity of biological information, experiments, inferences and statements.

6.3	Experiment and investigation (AO3)	a. devise and plan experimental and investigative activities, selecting appropriate techniques; b. Demonstrate safe and skilful practical techniques; c. make observations and measurements with appropriate precision and record these methodically; d. interpret, explain, evaluate and communicate the results of their experimental and investigative activities clearly and logically using biological knowledge and understanding and using appropriate specialist vocabulary.

At A Level

6.4	Synthesis of knowledge, understanding and skills (AO4)	a. bring together principles and concepts from different areas of biology and apply them in a particular context, expressing ideas clearly and logically and using appropriate specialist vocabulary; b. use biological skills in contexts which bring together different areas of the subject.
6.5	Quality of Written Communication	The quality of written communication is assessed in both the AS and A2 assessment units where candidates are required to produce extended written material. Candidates will be expected to: • select and use a form and style of writing appropriate to purpose and complex subject matter; • organise relevant information clearly and coherently, using specialist vocabulary when appropriate; • ensure text is legible, and spelling, grammar and punctuation are accurate, so that meaning is clear. The assessment of the quality of written communication is included in all the Assessment Objectives.

7 Scheme of Assessment – *Advanced Subsidiary (AS)*

The Scheme of Assessment has a modular structure. The Advanced Subsidiary (AS) award comprises three compulsory assessment units.

For Biology the Units are 1, 2 and 4.

For Human Biology the Units are 1, 3 and 4.

7.1 Assessment Units

Unit 1	(*Biology and Human Biology*)
	Written Unit 1½ hours
35% of the total AS marks	75 marks

This unit comprises short answer and structured questions which assess **Module 1** of the subject content:

Molecules, Cells and Systems

All questions are compulsory.

Unit 2	(*Biology only*)
	Written Unit 1½ hours
35% of the total AS marks	75 marks

This unit comprises short answer and structured questions which assess **Module 2** of the subject content:

Making use of Biology

All questions are compulsory.

Unit 3	(*Human Biology only*)
	Written Unit 1½ hours
35% of the total AS marks	75 marks

This unit comprises short answer and structured questions which assess **Module 3** of the subject content:

Pathogens and Disease

All questions are compulsory.

Unit 4	(*Biology and Human Biology*)
30% of the total AS marks	Centre-assessed Coursework 30 marks

This unit assesses the practical, **Module 4**. It requires candidates to plan, carry out and evaluate their work and should involve the use of IT where appropriate.

It is marked by the teacher and moderated by AQA.

Further guidance can be found in Sections 20 – 25.

7.2 Weighting of Assessment Objectives for AS

The approximate relationship between the relative percentage weighting of the Assessment Objectives (AOs) and the overall Scheme of Assessment is shown in the following table.

Assessment Objectives	Unit Weightings (%)			Overall Weighting of AOs (%)
	1	2/3	4 *	
Knowledge with understanding (AO1)	20	20	10	50
Application of knowledge and understanding, analysis, synthesis and evaluation (AO2)	15	15	5	35
Experiment and investigation (AO3)	0	0	15	15
Synthesis of knowledge, understanding and skills (AO4)	0	0	0	0
Overall Weighting of Units (%)	35	35	30	100

* Centre-assessed Coursework

Candidates' marks for each assessment unit are scaled to achieve the correct weightings.

8 Scheme of Assessment – *Advanced Level (AS+A2)*

The Scheme of Assessment has a modular structure. The A Level award comprises three compulsory assessment units from the AS Scheme of Assessment and three compulsory assessment units from the A2 Scheme of Assessment.

	Advanced Level Units	
	AS	**A2**
Biology	1, 2, 4	5, 6, 8a and 8b
Human Biology	1, 3, 4	5, 7, 9a and 9b

The details of the AS Assessment Units are given in Section 7 above and comprise the following units.

8.1 AS Assessment Units

Unit 1 (*Biology and Human Biology*)
Written Unit 1½ hours
17.5% of the total A Level marks 75 marks

Unit 2 (*Biology only*)
Written Unit 1½ hours
17.5% of the total A Level marks 75 marks

Unit 3 (*Human Biology only*)
Written Unit 1½ hours
17.5% of the total A Level marks 75 marks

Unit 4 (*Biology and Human Biology*)
Centre-assessed Coursework
15% of the total A Level marks 30 marks

8.2 A2 Assessment Units

Unit 5 (*Biology and Human Biology*)
Written Unit 1½ hours
15% of the total A Level marks 75 marks

This unit comprises short answer and structured questions and assesses **Module 5** of the subject content:

Inheritance, Evolution and Ecosystems

All questions are compulsory.

Unit 6	(*Biology only*)
	Written Unit 1½ hours
15% of the total A Level marks	75 marks

This unit comprises short answer and structured questions which assess **Module 6** of the subject content:

Physiology and the Environment

It will also include some synoptic assessment (AO4) of the earlier modules.

All questions are compulsory.

Unit 7	(*Human Biology only*)
	Written Unit 1½ hours
15% of the total A Level marks	75 marks

This unit comprises short answer and structured questions which assess **Module 7** of the subject content:

The Human Life-Span

It will also include some synoptic assessment (AO4) of the earlier modules.

All questions are compulsory.

Unit 8a	(*Biology only*)
	Written Unit 1¾ hours
10% of the total A Level marks	60 marks
Unit 9a	(*Human Biology only*)
	Written Unit 1¾ hours
10% of the total A Level marks	60 marks
Unit 8b/9b	(*Biology and Human Biology*)
	Centre-assessed Coursework
10% of the total A Level marks	21 marks

Unit 8a/9a comprises 2 structured questions and 1 essay question which tests synoptic skills (AO4). There will be a choice of essay titles.

Unit 8b/9b assesses similar practical skills to Unit 4 with more emphasis on synoptic skills (AO4).

The marks for Unit 8a and 8b and similarly 9a and 9b will be combined to give an overall result for Units 8 and 9.

Further guidance can be found in Sections 20 – 25.

8.3 Synoptic Assessment

The Advanced Subsidiary and Advanced Level Criteria state that A Level specifications must include synoptic assessment representing 20% of the total A Level marks (AO4).

In this specification the synoptic assessment is allocated as follows:

Unit 6/7	–	5%	}	
			}	(externally assessed)
Unit 8a/9a	–	10%	}	
Unit 8b/9b	–	5%		(internally-assessed)

8.4 Weighting of Assessment Objectives for A Level

The approximate relationship between the relative percentage weighting of the Assessment Objectives (AOs) and the overall Scheme of Assessment is shown in the following table.

A Level Assessment Units (AS + A2)

Assessment Objectives	Unit Weightings (%)						Overall Weighting of AOs (%)
	1	2/3	4*	5	6/7	8*/9*	
Knowledge with understanding (AO1)	10	10	5	7.5	5	0	37.5
Application of knowledge and understanding analysis, synthesis and evaluation (AO2)	7.5	7.5	2.5	7.5	5	0	30
Experiment and investigation (AO3)	0	0	7.5	0	0	5	12.5
Synthesis of knowledge, understanding and skills (AO4)	0	0	0	0	5	15	20
Overall Weighting of Units (%)	17.5	17.5	15	15	15	20	100

Candidates' marks for each assessment unit are scaled to achieve the correct weightings.

4* is a centre-assessed component.

8*/9* - These units contain a written component (8a and 9a) and a centre-assessed component (8b and 9b).

Subject Content

9 Summary of Subject Content

9.1 AS Modules

MODULE 1 - Molecules, Cells and Systems (Biology and Human Biology)

Most organisms are organised on a cellular basis. Biochemical reactions occur within cells and these are regulated by the action of enzymes and limited by the passage of substances across plasma membranes. In larger organisms, cells are organised into tissues and tissues into organs which have specific functions. Organisms exchange substances with their environment and transport these substances from one part of the body to another by mass flow systems.
It is anticipated that this module will allow consideration of the principles to be stressed rather than biochemical detail and will provide an introduction to the acquisition of, and opportunities to assess, appropriate laboratory skills.

MODULE 2 - Making use of Biology (Biology only)

Biology influences our everyday lives in many ways. Enzymes can be isolated from microorganisms and have important applications in industry and in medicine. A knowledge of the way in which genes code information that leads to the synthesis of specific proteins has many applications such as in the production of specific proteins and in forensic investigation. In agriculture, an understanding of physiological processes has enabled us to increase the productivity of crop plants and domestic animals.
It is anticipated that this module will allow the continued development of basic skills as well as the opportunity to discuss the ethical and moral issues that relate to the subject.

MODULE 3 - Pathogens and Disease (Human Biology only)

A variety of pathogenic organisms can cause human disease. These range from viruses and bacteria to larger parasites. They show adaptations which enable them to infect new hosts and survive inside.

The blood, however, has a number of defensive functions which limit the effects of many pathogens. A knowledge of the way in which genes code information, that results in the synthesis of specific proteins, can lead to an understanding of the way in which certain diseases are caused, as well as allowing the production of specific proteins that can be used in their treatment and control. Non-communicable diseases such as heart disease and cancers also have a significant impact on human health. Biotechnology has allowed the development of a variety of methods for the diagnosis and control of disease.
It is anticipated that this module will allow the continued development of basic skills as well as the opportunity to discuss the ethical and moral issues that relate to the subject.

MODULE 4 – Centre-Assessed Coursework (Biology and Human Biology)

Teacher assessment of practical skills (See Section 20).

9.2 A2 Modules

MODULE 5 – Inheritance, Evolution and Ecosystems (Biology and Human Biology)

A Variation and the Mechanisms of Inheritance and Evolution

Genetic information is copied and transmitted from generation to generation. Natural selection acting on genetic variation is thought to have led to the enormous diversity of living organisms.

B The Biology of Ecosystems

Living organisms do not live in isolation but form structured communities within dynamic and well defined ecosystems through which energy flows and in which nutrients are cycled. This module also allows consideration of some of the ways in which human activity can impose far reaching effects on the environment. It is expected that candidates will carry out fieldwork involving the collection of quantitative data from at least one habitat and the application of elementary statistical analysis to the results.

MODULE 6 – Physiology and the Environment (Biology only)

Living organisms do not live in isolation. They are part of complex ecosystems in which they interact with the abiotic components. This module allows consideration of some of the physiological processes on which animals and plants depend. The emphasis throughout has been on adaptation to the environment.

MODULE 7 - The Human Life-Span (Human Biology only)

The processes of reproduction, growth and ageing demonstrate the importance of the interaction of physiological systems throughout the life of an individual.

MODULE 8a/9a - Synoptic Assessment (Biology / Human Biology)

A written paper testing synopsis of the AS and A2 content (see Specimen and Past Papers).

MODULE 8b/9b - Centre-Assessed Coursework (Biology / Human Biology)

Teacher assessment of practical skills (see Section 21).

10

AS Module 1 *(Biology and Human Biology) Molecules, Cells and Systems*

Most organisms are organised on a cellular basis. Biochemical reactions occur within cells and these are regulated by the action of enzymes and limited by the passage of substances across plasma membranes. In larger organisms, cells are organised into tissues and tissues into organs which have specific functions. Organisms exchange substances with their environment and transport these substances from one part of the body to another by mass flow systems.

It is anticipated that this module will allow principles to be stressed rather than biochemical detail and will provide an introduction to the acquisition of, and opportunities to assess, appropriate laboratory skills.

10.1 The cell is the basic unit of structure in prokaryotic and eukaryotic organisms

Prokaryotic cells	The main features of prokaryotic cells.
Eukaryotic cells	The structure of plant and animal cells as seen through an optical microscope. Practical work to include the preparation of temporary mounts, the use of simple staining techniques and the estimation of size.

10.2 The electron microscope and the technique of cell fractionation may be used to study ultrastructure

Electron microscopes	The principles and limitations of transmission and scanning electron microscopes. The difference between magnification and resolution.

Cell ultrastructure	Interpretation of electron micrographs.
	Identification of the principal features and organelles of a eukaryotic cell. Cell wall and plasma membranes, nucleus, chloroplasts, mitochondria, lysosomes, ribosomes, endoplasmic reticulum, Golgi apparatus, microvilli and vesicles.
	The functions of these structures.
	The principal features of a bacterium.
	Cell wall, capsule and genetic material.
Cell fractionation	Principles of cell fractionation and ultracentrifugation as used to separate cell components.

10.3 The properties of plasma membranes are related to the passage of substances through them

Plasma membranes	The arrangement of phospholipids, proteins and carbohydrates in the fluid-mosaic model of membrane structure.
Diffusion	Diffusion and the factors which determine its rate.
	A qualitative consideration of Fick's law i.e. diffusion rate is proportional to
	$\frac{\text{surface area} \times \text{difference in concentration}}{\text{thickness of exchange surface}}$
Water potential	Osmosis as the movement of water from a solution of less negative water potential to a solution of more negative water potential through a partially permeable membrane.
Active transport and facilitated diffusion	The role of protein molecules and energy in these processes.
Endo- and exocytosis	

10.4 Large molecules are important in the structure and functioning of cells

Biological molecules

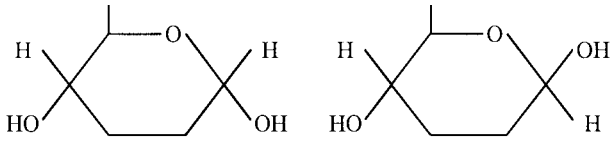
Biological molecules are based on a small number of chemical elements and frequently consist of monomers combined into polymers.

Condensation and hydrolysis.

Carbohydrates

Structure and properties of carbohydrates.

The structures of α-glucose and β-glucose as:



α glucose **β glucose**

and the linking of these monomers by glycosidic bonds.

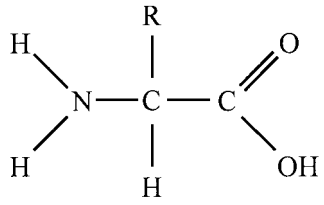
Biochemical tests using Benedict's reagent for reducing sugars and for non-reducing sugars after acid hydrolysis. Iodine/potassium iodide solution for starch.

The basic structure of starch, glycogen and cellulose and the relationship of structure to the function of these substances in living organisms.

Proteins

Structure of proteins.

The general structure of an amino acid molecule as:



and the linking together of amino acids with peptide bonds. Primary, secondary, tertiary and quaternary structure.

The relationship between the tertiary structure of a globular protein, its shape and its function.

The biuret test for proteins.

Lipids	The structure of lipids to include only saturated and unsaturated triglycerides and phospholipids. The emulsion test for lipids.
Chromatography	The technique of chromatography to illustrate how molecules may be separated and identified. The calculation and use of R_f value. Two-way chromatography.

10.5 Enzymes are proteins which control biochemical reactions in cells

Enzyme action	The protein nature of enzymes. Enzymes as catalysts lowering activation energy through the formation of enzyme-substrate complexes. The lock and key and induced fit models of enzyme action.
Factors which affect enzyme activity	Description and explanation of the effects of temperature, pH, substrate and enzyme concentration and competitive and non-competitive inhibitors should be considered.

10.6 Tissues contain similar cells, and organs are structures made of different tissues

Epithelial tissue	Epithelial tissue lines many organs. The essential features of the alveolar epithelium as a surface over which gas exchange takes place.
Blood	Blood is specialised tissue containing a number of different cell types. Confined to recognition of red blood cells, lymphocytes, monocytes and granulocytes. The structure of red blood cells in relation to their transport function. The relationship between size and surface area to volume ratio.

	Blood vessels	Blood vessels as examples of organs. The structure of arteries, arterioles and veins in relation to their function.
10.7	The blood system is a mass flow system which moves substances from one part of the body to another. It is linked with exchange surfaces	
	Circulation	The general pattern of blood circulation in a mammal. Names only required of the carotid artery and of blood vessels entering and leaving the heart, liver and kidneys.
	Capillaries	The structure of capillaries and their importance in metabolic exchange. The formation of tissue fluid and its return to the circulatory system. *Details of the lymphatic system are **not** required.*
	Lung function	The gross structure of the human gas-exchange system. The exchange of respiratory gases in the lungs. Fick's law, (section 10.3) provides an effective framework for consideration of how the maximum rate of diffusion of respiratory gases is achieved. *Details of transport of oxygen and carbon dioxide in the blood are **not** required. This is covered in Section 15.5 of Module 6 and 16.6 of Module 7.*
	Ventilation	Mechanism of ventilation and its nervous control. The composition of inhaled and exhaled air. The role of the medulla and the phrenic nerves in generating a basic breathing rhythm.
10.8	The functioning of the heart plays a central role in the circulation of blood and relates to the level of activity of an individual	
	Heart structure	The gross structure of the heart in relation to its function.

Heart function	Pressure and volume changes and associated valve movements during the cardiac cycle.
	Myogenic stimulation of the heart and transmission of a subsequent wave of electrical activity.
	Roles of sinoatrial node, atrioventricular node and bundle of His.
Effects of exercise	Cardiac output as the product of heart rate and stroke volume. Pulmonary ventilation as the product of tidal volume and breathing rate.
	Changes in cardiac output and pulmonary ventilation with exercise.
	Nervous control of heart rate in relation to changing demands.
	Redistribution of blood flow in response to varying degrees of exercise.
	The relative stability of blood supply to the brain, kidneys and heart and the increase to skeletal muscle.

11 AS Module 2 (Biology only) *Making Use of Biology*

Biology influences our everyday lives in many ways. Enzymes can be isolated from microorganisms and have important applications in industry and in medicine. A knowledge of the way in which genes code information that leads to the synthesis of specific proteins has many applications such as in the production of specific proteins and in forensic investigation. In agriculture, an understanding of physiological processes has enabled us to increase the productivity of crop plants and domestic animals.

It is anticipated that this module will allow the continued development of basic skills as well as the opportunity to discuss the ethical and moral issues that relate to the subject.

11.1 Enzymes may be isolated from microorganisms and have important applications in biotechnological processes

Isolation of enzymes

The distinction between intracellular and extracellular enzymes.

A suitable example should be chosen to show that the commercial production of enzymes from microorganisms involves:

- the growth of large numbers of microorganisms using specific media and aseptic conditions;
- the isolation and purification of the enzyme product by downstream processing.

Application of enzymes in biotechnological processes

The applications of enzymes should be linked to a consideration of their functions (Module 1, Section 10.5)

Suitable examples should be selected to demonstrate that:

- because of their high sensitivity and specificity, enzymes may be used as analytical reagents;
- industrial processes require a high degree of thermostability;
- immobilised enzymes can be separated easily from reactants and products and can thus give a higher degree of control; they are also more stable.

11.2 Genetic information is passed from cell to cell during division

Mitosis	The process of mitosis emphasising the behaviour of chromosomes, the role of the spindle and the genetic identity of the products. Use of appropriate staining techniques in the study of mitosis in suitable plant material.
The cell cycle	Mitosis and the cell cycle. The relationship between DNA replication and the events of the cell cycle.
Meiosis	The importance of meiosis in halving the chromosome number in gametes so that, after fertilisation, the diploid chromosome number is restored in the resulting zygote. *Details of chromosome behaviour are **not** required. This is covered in section 14.1 of Module 5.*

11.3 Genes incorporate coded information which determines the metabolism of organisms

	The structure of DNA, mRNA and tRNA in terms of nucleotides, base pairing and hydrogen bonding.
DNA as genetic material	Evidence that DNA is the genetic material. *Candidates will **not** be expected to link workers' names with particular pieces of work or to be familiar with the details of techniques. The exercise for candidates should be one of analysis and deduction using evidence derived from experimental work.*
The structure of nucleic acids	This topic should be covered in sufficient detail to provide an understanding of the roles of nucleic acids in coding information, protein synthesis and the replication of DNA.
Replication of DNA	The semi-conservative replication of DNA.
Protein synthesis	The genetic code as a non-overlapping, degenerate code. Introns as non-coding DNA. The mechanism of protein synthesis involving the roles of mRNA, tRNA and the ribosomes. Enzymes as proteins whose synthesis is controlled by DNA. They control metabolic pathways and thus influence the phenotype of an organism.

11.4 Gene technology has many applications in a modern world

Recombinant DNA

The production of recombinant DNA and its use in the production of human insulin and other proteins.

Consideration should be given to the:

- isolation of the gene coding for the required protein;
- use of the enzymes: reverse transcriptase, restriction endonuclease and ligase;
- sticky ends; insertion of the gene into a vector and its subsequent introduction into host cells; plasmids and viruses as examples of vectors;
- use of genetic markers such as genes conferring antibiotic resistance to detect genetically modified organisms;
- multiplication of host cells.

The moral and ethical issues associated with recombinant DNA technology.

11.5 Forensic examination of blood may draw on the principles of blood grouping and genetic fingerprinting

Principles of immunology

Definition of antigen and antibody. The immunological response of B-lymphocytes to stimulation by the appropriate antigen in terms of production of plasma cells, memory cells and antibodies.

ABO blood groups can be distinguished by antigens present on the plasma membranes of red blood cells.
Agglutination occurs when blood of a specific group is mixed with an appropriate antibody. This reaction forms the basis of blood grouping.
The inheritance of ABO blood groups is not required.

Genetic fingerprinting

The technique of genetic fingerprinting may be used to identify individual blood samples.

This process should be considered in such detail as to show that:

- restriction enzymes are used to cut DNA into fragments;
- electrophoresis is used to sort DNA fragments according to size;
- radioactive DNA probes are used to locate specific DNA fragments;

Polymerase chain reaction

The polymerase chain reaction and its importance in obtaining increased amounts of DNA for analysis.

11.6 Cultivated plants are adapted to survive in particular environments. Humans can manipulate the environment of these plants to increase productivity

Adaptations of cereals

Cereals form an important part of the human diet. Different species of cereal show structural and physiological adaptations which enable them to grow in different parts of the world.

Consideration should be given to each of the cereals named below:

- rice as a swamp plant with hollow aerenchyma and a tolerance to ethanol produced by anaerobic respiration;
- sorghum as a plant which grows in hot, dry conditions; its xerophytic modifications include the presence of an extensive root system, a thick cuticle and a reduced number of sunken stomata; both the adult plants and the embryos can tolerate high temperatures;
- maize as a tropical plant with a specialised method of photosynthesis; the advantages of this method of photosynthesis in increased efficiency at high temperature and low carbon dioxide concentrations. *The biochemical details of photosynthesis are* ***not*** *required.*

Controlling the abiotic environment

Humans can change the abiotic environment of crop plants.

The effect of light intensity, temperature and carbon dioxide concentration on rate of photosynthesis and productivity. Enhancement of these factors in commercial glasshouses.

Fertilisers

Harvesting removes nutrients from the soil.
The use of fertilisers to replace these.

The advantages and disadvantages of organic and inorganic fertilisers.
The relationship between yield and the quantity of fertiliser added.
The environmental issues arising from the use of fertilisers. Leaching and eutrophication.

Pesticides	Interspecific competition between weeds and crop plants. Reduction of crop yield by insects either directly, or indirectly by reducing the photosynthetic tissues of the plant. The principles of using chemical pesticides, biological agents and integrated systems in controlling pests of agricultural crops. The environmental issues associated with pest control. Toxicity and bioaccumulation. Candidates should be able to evaluate the issues involved in using different methods to control the pests.

11.7 Biotechnology allows the manipulation of reproduction in humans and domestic animals

Reproduction and its hormonal control	The development of ovarian follicles and corpora lutea and changes in the uterine endometrium during the sexual cycle in a female mammal. The hormonal control of the female sexual cycle in a mammal. The roles of FSH, LH, oestrogen and progesterone. The detection and significance of oestrus in a **named** farm animal.
Manipulation and control of reproduction	The use of extracted and synthetic hormones as contraceptives and in controlling human infertility. In domestic animals, the role of hormones in: • producing large numbers of embryos for transplanting; • synchronising breeding behaviour in sheep; • increasing milk production. The moral and ethical issues associated with using biotechnology to manipulate reproduction.

12

AS Module 3 *(Human Biology only)* *Pathogens and Disease*

A variety of pathogenic organisms can cause human disease. These range from viruses and bacteria to larger parasites. They show adaptations which enable them to infect new hosts and survive inside. The blood, however, has a number of defensive functions which limits the effects of many pathogens. A knowledge of the way in which genes code information for the synthesis of specific proteins can lead to an understanding of the way in which certain diseases are caused, as well as allowing the production of specific proteins that can be used in their treatment and control. Non-communicable diseases such as heart disease and cancers also have a significant impact on human health. Biotechnology has allowed the development of a variety of methods for the diagnosis and control of disease.

It is anticipated that this module will allow the continued development of basic skills as well as the opportunity to discuss the ethical and moral issues that relate to the subject.

12.1 Bacteria and viruses are examples of pathogenic microorganisms

Bacteria

The sigmoid growth curve of a bacterial population and the characteristic log, lag, stationary and decline phases.
The effect of temperature and nutrient availability on the growth of bacterial populations.

Practical work to include investigations into population growth of bacteria or yeast, involving sterile technique and the use of a haemocytometer.

Viruses

The structure of the human immunodeficiency virus (HIV) and its replication.

The association of microorganisms with disease

Koch's postulates.

Disease can result from pathogenic organisms penetrating any of the body's interfaces with the environment.

Microorganisms can cause disease by damaging the cells of the host and by producing toxins.

These principles should be illustrated by reference to the following organisms where appropriate:

Salmonella spp.
Mycobacterium tuberculosis
HIV

12.2 The parasites responsible for malaria and schistosomiasis show structural and physiological adaptations which enable them to infect new hosts and survive inside them

Parasites and parasitism

The principal adaptations of parasites to their way of life as illustrated by *Plasmodium* and *Schistosoma*.

These organisms should be studied in sufficient detail to illustrate:

- their ability to survive in the hostile environment within the host;
- reduction of locomotory and other structures;
- modification of reproduction and the life cycle associated with infecting a new host.

12.3 Mammalian blood possesses a number of defensive functions

General mechanism of defence against disease

Phagocytosis and the subsequent destruction of ingested pathogens.

The roles of thromboplastins, prothrombin, plasma enzymes, calcium ions and fibrinogen in blood clotting.

Principles of immunology

Definition of antigen and antibody.

The essential difference between humoral and cellular responses as shown by B-lymphocytes and T-lymphocytes.
The role of plasma cells and memory cells in producing primary and secondary response.

Principles only should be stressed. *The function of cell types other than those specified and the classes of immunoglobulins are* ***not*** *required.*

Passive and active immunity	Passive immunity. Antibodies acquired naturally through the placenta and via lactation should be considered as well as those acquired artificially. Vaccination and immunisation. Attenuated and dead microorganisms, and genetic engineering (see section 12.5) as the basis for vaccines.

12.4 Genetic information is passed from cell to cell during division

Mitosis	The process of mitosis emphasising the behaviour of chromosomes, the role of the spindle and the genetic identity of the products. Use of appropriate staining techniques in the study of mitosis in suitable plant material.
The cell cycle	Mitosis and the cell cycle. The relationship between DNA replication and the events of the cell cycle.
Meiosis	The importance of meiosis in halving the chromosome number in gametes so that, after fertilisation, the diploid chromosome number is restored in the resulting zygote. *Details of chromosome behaviour are **not** required. This is covered in section 14.1 of Module 5.*

12.5 Genes incorporate coded information which determines the metabolism of organisms

	The structure of DNA, mRNA and tRNA in terms of nucleotides, base pairing and hydrogen bonding.
DNA as genetic material	Evidence that DNA is the genetic material. *Candidates will **not** be expected to link workers' names with particular pieces of work or to be familiar with the details of techniques. The exercise for candidates should be one of analysis and deduction using evidence derived from experimental work.*
The structure of nucleic acids	This topic should be covered in sufficient detail to provide an understanding of the roles of nucleic acids in coding information, protein synthesis and the replication of DNA.

Replication of DNA	The semi-conservative replication of DNA.
Protein synthesis	The genetic code as a non-overlapping, degenerate code. Introns as non-coding DNA. The mechanism of protein synthesis involving the roles of mRNA, tRNA and the ribosomes. Proteins whose synthesis is controlled by DNA control metabolic pathways and thus influence the phenotype of an organism. This section should be illustrated with reference to cystic fibrosis and phenylketonuria.

12.6 Gene technology may be used in combating disease

Recombinant DNA	The production of recombinant DNA and its use in the production of human insulin and other proteins. Consideration should be given to the: • isolation of the gene coding for the required protein; • use of the enzymes: reverse transcriptase, restriction endonuclease and ligase; • sticky ends; insertion of the gene into a vector and its subsequent introduction into host cells; plasmids and viruses as examples of vectors; • use of genetic markers such as genes conferring antibiotic resistance to detect genetically modified organisms; • multiplication of host cells. The moral and ethical issues associated with recombinant DNA technology.

12.7 Non-communicable disease includes heart disease and cancer

The biological basis of heart disease	Atheroma as the presence of fatty material within the walls of arteries. Explanation of the link between atheroma and the increased risk of aneurysm and thrombosis. Myocardial infarction and its cause in terms of an interruption to the blood flow to the heart muscle.

Risk factors associated with coronary heart disease.

Blood cholesterol, cigarette smoking and increased blood pressure.

The biological basis of cancer

The main characteristics of tumours and tumour cells.

The distinction between benign and malignant tumours.

Consideration should be given to the following aspects:

- genes and the part they play in the control of normal cell growth;
- chemical carcinogens and radiation may damage DNA and cause mutations in the genes controlling growth;
- tumour cells fail to respond to normal growth regulating processes; they undergo metastasis and invade other organs;
- the role of tumour suppressor genes in preventing tumour growth.

The incidence of lung and skin cancers in the United Kingdom.
Factors which increase the incidence of these cancers.
The emphasis should be placed on interpretation of data showing the pattern of incidence and links with possible causal factors.

The moral and ethical issues associated with cigarette smoking and disease.

12.8 Disease may be diagnosed by a variety of techniques

DNA probes and diagnosis

The use of DNA probes to identify the presence of specific genes associated with human disease.

This process should be considered in such detail as to show that:

- restriction enzymes are used to cut DNA into fragments;
- electrophoresis is used to sort fragments according to charge and size;
- radioactive DNA probes are used to locate specific DNA fragments.

Enzymes and diagnosis	Disease can result in changes in the concentration and distribution of enzymes in the body. Pancreatitis may result in increased concentrations of digestive enzymes in the blood or a decrease in the concentration of these enzymes in the gut. Because of their high sensitivity and specificity, enzymes may be used as analytical reagents. The use of glucose oxidase and peroxidase in testing for glucose.

12.9 Drugs are used in the control and treatment of disease

Betablockers	Beta blockers as drugs which can be used to reduce hypertension by binding to receptor molecules.
Antibiotics	Antibiotics may be used to treat bacterial disease by preventing the formation of bacterial cell walls or interfering with the processes of DNA replication and protein synthesis. The importance of the cell wall in preventing osmotic lysis. Bacteriostatic and bactericidal antibiotics and their effect on bacterial populations. *The mode of action of specific antibiotics will* ***not*** *be required.*
Monoclonal antibodies	The use of monoclonal antibodies in enabling the targeting of specific substances and cells. *The method of production of monoclonal antibodies will* ***not*** *be required.*

13

AS Module 4
(Biology and Human Biology)
Centre-Assessed Coursework

Candidates will be assessed on the following ten practical skills.

A. Method of changing the independent variable.

B. Method of measuring the dependent variable.

C. Implementation of practical work.

D. Collection and presentation of raw data.

E. Drawing.

F. Analysing.

G. Drawing conclusions.

H. Evaluating.

I. Selecting and retrieving information.

J. Communicating.

This component will be marked by the teacher and moderated by AQA.

For further details see Section 20.

Evidence of the Skills in the shaded boxes A, B, F, G, H, I and J must be sent to the AQA moderator for each candidate in the sample. It is recognised that the ephemeral nature of skills C, D and E makes them unsuitable for moderation.

14

A2 Module 5 *(Biology and Human Biology) Inheritance, Evolution and Ecosystems*

A. Variation and the Mechanisms of Inheritance and Evolution

Genetic information is copied and transmitted from generation to generation. Natural selection acting on genetic variation is thought to have led to the enormous diversity of living organisms.

14.1 Continuity is maintained by the transmission of genetic information from generation to generation

Meiosis

The process of meiosis emphasising the reduction in chromosome number and the independent assortment of homologous chromosomes, chiasma formation and the exchange of genetic material between homologous chromosomes.
*Names of subdivisions of prophase I are **not** required.*

The principles of Mendelian inheritance

Candidates may be asked to solve problems involving any of the following four features presented as data derived from specific crosses or as pedigrees:

- monohybrid and dihybrid crosses;
- multiple alleles;
- sex linkage;
- codominance.

*Autosomal linkage is **not** required.*

Reasons why experimental results may be expected only to approximate to Mendelian ratios.

Application of chi-squared test to data obtained.

14.2 Genetic and environmental factors influence variation between individuals

Investigating variation

The need for random sampling and the importance of chance in contributing to differences between samples.

Collection and display of data by means of appropriate graphical techniques.

The concept of normal distribution about a mean. Understanding of mean and standard deviation as a measure of the variation in a sample.

The calculation and interpretation of standard error.

*Candidates will **not** be required to calculate either standard deviation or standard error in answer to questions on written papers.*

The causes of variation

Variation exists between members of a species.

The significance of meiosis in generating genetic variation.

Gene mutation. Restricted to substitution, addition and deletion of bases.

Interaction of genetic and environmental factors resulting in the phenotype.

Polygenic inheritance.

14.3 Selection can influence the frequency of alleles in a population

The Hardy-Weinberg principle

The concept of the gene pool.

The Hardy-Weinberg equation and the conditions under which it applies.

Calculation of allele, genotype and phenotype frequencies from appropriate data and from the Hardy-Weinberg equation.

$$p^2 + 2pq + q^2 = 1$$

Selection and change in allele frequency

The concept of change in allele frequency due to selection. Directional, stabilising and disruptive selection.

Examples chosen to illustrate this concept should include a study of the incidence of sickle-cell anaemia in relation to malaria and consideration of the evolution of resistance to pesticides and antibiotics as an example of the effect of human activity.

Speciation

The importance of reproductive isolation in the formation of new species.

Allopatric and sympatric speciation.

14.4 Evolution has resulted in different species of organisms. They are classified into five kingdoms

The concept of a species	Definition of species in terms of variation and potential for breeding.
The five-kingdom classification	Recognition that kingdoms are divided into phyla, classes, orders, families, genera and species. The classification of living organisms into five kingdoms: Prokaryotae, Protoctista, Fungi, Plantae and Animalia. The distinguishing characteristics of each kingdom. This hierarchy should be illustrated with reference to the classification of familiar organisms. *Candidates will **not** be expected to recall classification of individual organisms.*

B. The Biology of Ecosystems

Living organisms do not live in isolation but form structured communities within dynamic and well-defined ecosystems through which energy flows and in which nutrients are cycled. This section also considers some of the ways in which human activity can impose far-reaching effects on the environment. It is expected that candidates will carry out fieldwork involving the collection of quantitative data from at least **one** habitat and the application of elementary statistical analysis to the results.

14.5 The concept of an ecosystem

Ecological terms	An understanding of the following ecological terms: • ecosystem; • community; • population; • environment; • habitat; • niche.

Investigating numbers and distribution	A critical appreciation of some of the ways in which the numbers and distribution of organisms may be investigated. Random sampling with quadrats and counting along transects to obtain quantitative data. The use of mark-release-recapture techniques for more mobile species.
Diversity	An understanding of the concept of diversity in the context of ecological stability. Calculation of an index of diversity from the formula $$d = \frac{N(N-1)}{\sum n(n-1)}$$ where N = total number of organisms of all species and n = total number of organisms of each species. • In extreme environments the diversity of organisms is usually low. This may result in an unstable ecosystem in which populations are usually dominated by abiotic factors. • In less hostile environments the diversity of organisms is usually high. This may result in a stable ecosystem in which populations are usually dominated by biotic factors.
Succession	Succession from pioneer species to climax community. Changes in abiotic factors resulting in a less hostile environment and increasing diversity.

14.6 Photosynthesis uses energy from sunlight to synthesise organic molecules from inorganic sources

The biochemistry of photosynthesis	The light-independent and light-dependent reactions in a typical C_3 plant. These processes should be considered only in such detail as to show that (i) in the light-dependent reactions: • electrons in chlorophyll are excited by light energy;

- energy from these excited electrons generates ATP and reduced NADP;
- photolysis of water produces protons and electrons;
- oxygen is a valuable waste product of photolysis.

(ii) in the light-independent reactions:

- ribulose bisphosphate (RuBP) acts as a carbon dioxide acceptor leading to the formation of two molecules of glycerate 3-phosphate (GP);
- ATP and reduced NADP are required for the reduction of GP to triose phosphate;
- RuBP is regenerated in the Calvin cycle;
- Triose phosphate is converted to useful carbohydrates, amino acids and lipids.

Chloroplasts	The role of chloroplasts in photosynthesis.

14.7 Energy is transferred through food chains and food webs in a community.

Ecological pyramids	Pyramids of number, biomass and energy. The trophic levels of producer, primary and secondary consumer and decomposer.
Transfer of energy between trophic levels	A quantitative consideration of the transfer of energy between trophic levels and its relative efficiency.

14.8 Respiration produces ATP which is the immediate form of energy for many cell activities

Respiratory substrates and respiratory quotient (RQ)	The use of different respiratory substrates and the determination, calculation and interpretation of RQ. RQ should be considered with reference to lipid, protein and carbohydrate.
The biochemistry of respiration	The release of energy from carbohydrate by aerobic respiration. The production of ethanol or lactate and the regeneration of NAD in anaerobic respiration.

These processes should be considered only in such detail as to show that:

- glycolysis involves the oxidation of glucose to pyruvate with the net gain of ATP and reduced NAD;
- acetylcoenzyme A is produced from pyruvate and coenzyme A in the link reaction;
- acetylcoenzyme A combines with a 4-carbon molecule to produce a 6-carbon molecule in the Krebs cycle;
- in a series of oxidation-reduction reactions, the Krebs cycle generates reduced coenzymes and ATP by substrate-level phosphorylation and carbon dioxide is lost;
- oxidative phosphorylation leads to the aerobic generation of ATP via a chain of electron carriers;
- aerobic respiration is more efficient than anaerobic respiration in terms of ATP production.

The roles of the cytoplasm and of the mitochondria in these processes.

The role of ATP	ATP as an immediate source of energy in active transport, glycolysis, photosynthesis and other metabolic processes.

14.9 Decomposition and recycling maintain the balance of nutrients in an ecosystem

Carbon and nitrogen cycles	The importance of respiration and photosynthesis in giving rise to short-term fluctuations and in the long-term global balance of oxygen and carbon dioxide. The passage of nutrients through various trophic levels and the role of microorganisms in converting organic molecules to inorganic substances which are made available to plants. Illustrated with reference to the carbon and nitrogen cycles.

14.10 Human activity can impose far-reaching effects on an ecosystem. There is a potential conflict of interest between production and conservation

Deforestation

Deforestation leading to the increase in land for agriculture. The influence of deforestation on diversity and on carbon and nitrogen cycling.

Conservation of forests allowing sustainable provision of resources.

Specific knowledge will be required of this example only, although candidates may be required to interpret other material illustrating the general theme of this section.

15

A2 Module 6
(Biology only)
Physiology and the Environment

Living organisms do not live in isolation. They are part of complex ecosystems in which they interact with the abiotic components. In this module, consideration has been given to some of the physiological processes on which animals and plants depend. The emphasis throughout is on adaptation to the environment.

15.1 Abiotic factors influence uptake and loss of water in flowering plants

The passage of water through a plant

The structure of a dicotyledonous root in relation to uptake and movement of water across the root by apoplastic and symplastic pathways.

The structure of xylem vessels and their distribution in the stem of a herbaceous dicotyledon.

Evidence for, and limitations of, theories which explain movement in xylem.

Capillarity, root pressure and cohesion-tension should be considered.

Transpiration and a quantitative study of the factors which affect water loss.

Candidates should be familiar with the use of a simple potometer for measuring water uptake.

Xerophytes

Structural adaptations which promote the uptake of water and control its loss in xerophytes.

15.2 Homeostatic mechanisms function to maintain the body in a state of equilibrium and allow a degree of independence from the environment

Principles of Homeostasis

The control of temperature and blood glucose should be used to illustrate the following principles:

- homeostasis provides a constant internal environment and independence from fluctuating external conditions;
- negative feedback tends to restore systems to their original levels;
- the possession of separate mechanisms controlling departures in different directions from the original state gives a greater degree of control;
- control mechanisms must be coordinated.

Temperature control

The contrasting mechanisms of temperature control in an ectothermic reptile and an endothermic mammal. Mechanisms involved in heat production, conservation and loss. The role of the hypothalamus and autonomic nervous systems in temperature control in a mammal.

Control of blood glucose concentration

The factors which influence blood glucose concentration.

Role of hormones in activating enzymes involved in the interconversion of glucose and glycogen.
*Details of biochemical pathways and individual enzymes are **not** required.*

The roles of insulin and glucagon in controlling blood glucose.

Diabetes and its control with insulin and by manipulation of carbohydrate intake.

15.3 The functions of the liver and kidney are essential to homeostasis

The liver as a homeostatic organ

Methods of removing nitrogenous waste

Animals have different methods of removing nitrogenous waste. The following should be considered:

- ammonia in fish;
- uric acid in insects and birds;
- urea in mammals;

The emphasis should be placed on the link between physiology and the environment of the organism concerned.
*Details of biochemical pathways are **not** required in this section.*

Deamination and the production of urea

This process should be considered only in such detail as to show that:

- the amino group is removed from an amino acid;
- the remainder of the amino acid molecule may be used in respiration;
- the nitrogenous product of deamination is ammonia which is converted to urea.

Kidney function

The structure and arrangement of a nephron and its associated blood vessels within the kidney in relation to its function.

The ultrastructure of the glomerulus, renal capsule and cells of the first convoluted tubule should be studied in relation to their functions:

- the production of glomerular filtrate by ultrafiltration in the renal capsule;
- reabsorption in the first convoluted tubule;
- the countercurrent multiplier hypothesis.

Water balance

The roles of the kidney and antidiuretic hormone (ADH) in the homeostatic regulation of water. Details of hormonal control restricted to ADH.

Control of the water budget in small desert mammals.

Meeting of water requirements largely from preformed and metabolic water.

Minimisation of respiratory, cutaneous and excretory loss.

Behavioural adaptations.

15.4 There is a conflict between the need for an efficient gas exchange system and the control of water loss

Gas exchange surfaces

Essential features of surfaces over which gas exchange takes place. Fick's law provides an effective framework for consideration of how the maximum rate of diffusion of respiratory gases is achieved:

- by the body surface of a protoctistan;
- in a fish gill;
- in the tracheal system of insects;
- in the spongy mesophyll of a leaf.

Limiting water loss

Structural and functional compromises between the opposing needs for efficient gas exchange and limiting water loss shown by terrestrial insects and mesophytic plants.

15.5 Respiratory gases are transported between exchange surfaces and the individual cells of an organism

The transport of respiratory gases

The roles of haemoglobin and hydrogencarbonate ions in the carriage of respiratory gases and the control of blood pH.

The oxyhaemoglobin dissociation curve.

The Bohr effect.

Candidates should be aware that different organisms possess different types of haemoglobin with different oxygen transporting properties. They should be able to relate these to the environment and way of life of the organism concerned.

15.6 The digestive system in mammals involves the chemical breakdown of food and its absorption from the gut

Digestion of food

The importance of hydrolytic enzymes as illustrated by the digestion of:

- starch – the role of salivary and pancreatic amylases and of maltases located in the cells of the intestinal epithelium;
- proteins – exopeptidases and endopeptidases, activation of trypsinogen and pepsinogen, peptidases located in the cells of the intestinal epithelium;
- lipids – pancreatic lipase, the role of bile;
- cellulose – the mutualistic relationship between ruminants and rumen microorganisms emphasising the ability of ruminants to survive on diets poor in protein.

Absorption of products of digestion

Histology of the ileum in relation to its secretory and absorptive functions.

The layers of the gut wall and the ultrastructure of the epithelium.

Absorption and active uptake of the products of digestion.

Control of digestive secretions

Nervous and hormonal control of salivary, gastric and pancreatic secretions.

The importance of simple and conditioned reflexes and the hormones gastrin, secretin and cholecystokinin-pancreozymin.

This section should be used to illustrate the important differences between nervous and hormonal control in animals.

15.7 The dietary requirements of organisms vary at different stages in their lives

Metamorphosis and insect diet

Metamorphosis as illustrated by the life cycle of a lepidopterous insect.

This section should reflect change in protein and energy requirements associated with growth in the larva and reproduction and dispersal in the adult. Associated changes in food and gut enzymes.

Specific knowledge will only be required of this example, although candidates may be required to interpret other material illustrating the general theme of this section.

15.8 Action potentials and synapses play a fundamental role in transmitting information through the nervous system

Neurones

The structure of a myelinated motor neurone.

Action potentials and nerve impulses

The role of the neurone membrane in the establishment of a resting potential.

Explained in terms of electrochemical gradients and the movement of sodium and potassium ions.

Change in membrane permeability leading to the generation of an action potential.

The all-or-nothing nature of nerve impulses.

Refractory period.

Saltatory conduction.

Factors affecting the speed of conductance: myelination, axon diameter and temperature.

Synaptic transmission	Consideration should be given to the following aspects of synaptic transmission: • undirectionality; • summation; • inhibition. Emphasis should be placed on an understanding of the mechanisms by which transmission may be affected rather than on knowledge of specific chemicals. The mechanism of transmission at an excitatory synapse. Knowledge of transmitters limited to acetylcholine and noradrenaline. The agonistic and antagonistic effects of chemicals on synaptic transmission.

15.9 Receptors convert stimuli into electrical impulses in nerve cells

Pacinian corpuscles	The basic structure of a Pacinian corpuscle as an example of a receptor. The creation of a generator potential on stimulation. The Pacinian corpuscle should be used as an example to illustrate the following: • receptors only respond to specific stimuli; • stimulation of receptor membranes produces deformation of stretch-mediated sodium channels leading to the establishment of a generator potential.
The eye	The structure of a mammalian eye and its transmissive and refractive properties in focusing an image on the retina. The role of rod cells and cone cells in effecting monochromatic and trichromatic vision. The absorption of light by rhodospin causes a chemical change leading to the creation of a generator potential. *Details of hyperpolarisation are* ***not*** *required.* The connection between sensory cells and the neurones of the optic nerve which allow sensitivity and acuity of vision.

15.10 Patterns of behaviour are integrated and controlled by the nervous system

Spinal Reflexes	The pathway and adaptive value of a simple spinal reflex involving three neurones.
The autonomic nervous system	An outline of the functions of the parasympathetic and sympathetic divisions of the autonomic nervous system. Specific physiological knowledge will only be required in the context of the control of heart rate.
Simple behaviour patterns	Taxes and kineses as simple responses which can maintain an organism in a favourable environment.

16

A2 Module 7 *(Human Biology only)* *The Human Life-Span*

The processes of reproduction, growth and ageing demonstrate the importance of the interaction of physiological systems throughout the life of an individual.

16.1 Sexual reproduction involves the production and transfer of gametes and the achievement of fertilisation

Gametes and gamete formation

The histology of the testis and ovary.

An outline of gametogenesis.
Considered in sufficient detail to show the processes of mitosis, meiosis, growth and maturation and the differences and similarities between gamete formation in males and females.

Fertilisation

The structure of a mature sperm cell and its movement through the female reproductive tract.

The acrosome reaction and penetration of the oocyte membranes.

16.2 The developing fetus in its uterine environment is dependent on its mother

Implantation and early development

The early development of the zygote to a blastocyst and its implantation.

Details of embryogenesis and the development of extra-embryonic membranes are ***not*** *required.*

The developing fetus

The following features of the circulatory system of the developing fetus:

- umbilical arteries and vein;
- ductus arteriosus;
- foramen ovale.

The structure and functions of the placenta.
Emphasis should be placed on the functional adaptations of the placenta for exchange and active transport.

Maternal physiology	The effect of pregnancy on aspects of maternal physiology: • thermal balance; • changes in blood volume and cardiac output and their significance. The role of hormones during pregnancy and in controlling birth and lactation. Confined to oestrogen, progesterone, human chorionic gonadotrophin, prolactin and oxytocin.

16.3 The processes of growth and development lead to the formation of mature organisms

Growth and its measurement	Methods of measuring growth. Supine length, standing height and body mass. Absolute growth and growth rate. The advantages and disadvantages of cross-sectional and longitudinal studies. Relative rates of growth of different tissues and organs from birth to adulthood in males and females. Growth of the body as a whole, the brain and head, lymphoid and reproductive tissues and organs.
Puberty	The physical and endocrinal changes associated with puberty. The role of the following hormones in controlling early growth and the changes associated with puberty: • growth hormone; • thyroxine; • pituitary gonadotrophins; • oestrogen and testosterone.

16.4 The digestive system in humans involves the chemical breakdown of food and its absorption from the gut

Digestion of food

The importance of hydrolytic enzymes as illustrated by the digestion of:

- starch – the role of salivary and pancreatic amylases and of maltases located in the cells of the intestinal epithelium;
- proteins – exopeptidases and endopeptidases, activation of trypsinogen and pepsinogen, peptidases located in the cells of the intestinal epithelium;
- lipids – pancreatic lipase, the role of bile;
- lactose – lactose intolerance and the occurrence of lactase enzymes in human populations.

Absorption of products of digestion

Histology of the ileum in relation to its secretory and absorptive functions.

The layers of the gut wall and the ultrastructure of the epithelium.

Absorption and active uptake of the products of digestion.

The principles of oral rehydration therapy in the control of gastro-intestinal infections.

Control of digestive secretions

Nervous and hormonal control of salivary, gastric and pancreatic secretions.

The importance of simple and conditioned reflexes and the hormones gastrin, secretin and cholecystokinin-pancreozymin.

This section should be used to illustrate the important differences between nervous and hormonal control.

16.5 Dietary requirements differ according to age, sex and occupation

The principal nutrients in the diet and their role in the body

Role of carbohydrates and lipids in the body.
Determination of energy content of food.
Simple laboratory techniques for estimating energy content of different foods. Sources of error in methods used.

Role of proteins in the body.
Essential and non-essential amino acids.
Transamination. *Biochemical pathways are **not** required.*

Simple qualitative tests on food.

Role of vitamins with respect to vitamin D and of inorganic ions illustrated by iron and calcium.

Dietary requirements

Concept of basal metabolic rate (BMR).
The relationship between BMR and body mass and surface area.

The pattern of energy expenditure and protein requirements associated with growth and ageing.

Rates of energy expenditure in adults engaged in different activities.
Glycogen loading and the enhancement of athletic performance.

The concept of a balanced diet and specific problems which may arise from vegetarian and weight-loss diets.

Dietary demands of pregnancy and lactation, restricted to protein, energy content, iron and calcium.

Requirements for iron in human females, related to menstrual loss.
Influence of IUDs and oral contraceptives on menstrual loss of iron.

16.6 Respiratory gases are transported between exchange surfaces and the individual cells of an organism

The transport of respiratory gases	The roles of haemoglobin and hydrogencarbonate ions in the carriage of respiratory gases and the control of blood pH.
	Comparison of adult and fetal haemoglobin.
	The oxyhaemoglobin dissociation curve.
	The Bohr effect.

16.7 Action potentials and synapses play a fundamental role in transmitting information through the nervous system

Neurones	The structure of a myelinated motor neurone.
Action potentials and nerve impulses	The role of the neurone membrane in the establishment of a resting potential explained in terms of electrochemical gradients and the movement of sodium and potassium ions.
	Change in membrane permeability leading to the generation of an action potential.
	The all-or nothing nature of nerve impulses.
	Refractory Period.
	Saltatory conduction.
	Factors affecting the speed of conductance: myelination, axon diameter and temperature.

Synaptic transmission

Consideration should be given to the following aspects of synaptic transmission:

- undirectionality;
- summation;
- inhibition.

Emphasis should be placed on an understanding of the mechanisms by which transmission may be affected rather than on knowledge of specific chemicals.

The mechanism of transmission at an excitatory synapse.
Knowledge of transmitters limited to acetylcholine and noradrenaline.

The agonistic and antagonistic effects of chemicals on synaptic transmission.

16.8 Receptors convert stimuli into electrical impulses in nerve cells

Pacinian corpuscles

The basic structure of a Pacinian corpuscle as an example of a receptor.

The creation of a generator potential on stimulation.

The Pacinian corpuscle should be used as an example to illustrate the following:

- receptors respond only to specific stimuli;
- stimulation of receptor membranes produces deformation of stretch-mediated sodium channels leading to the establishment of a generator potential.

The eye

The structure of a mammalian eye and its transmissive and refractive properties in focusing an image on the retina.

The role of rod cells and cone cells in effecting monochromatic and trichromatic vision.
The absorption of light by rhodopsin causes a chemical change leading to the creation of a generator potential.
Details of hyperpolarisation are ***not*** *required.*

The connection between sensory cells and the neurone of the optic nerve which allow sensitivity and acuity of vision.

16.9 Skeletal muscles are stimulated to contract by nerves and act as effectors

The sliding-filament theory of muscle contraction	Gross and microscopic structure of skeletal muscle including the ultrastructure of a myofibril.
	The roles of actin, myosin, calcium ions and ATP in myofibril contraction.
Muscles as effectors	The roles of ATP and phosphocreatine in providing the energy supply during muscle contraction.
	The structure, location and general properties of slow and fast skeletal muscle fibres.

16.10 Patterns of behaviour are integrated and controlled by the nervous system

Spinal reflexes	The pathway and adaptive value of a simple spinal reflex involving three neurones.
The autonomic nervous system	An outline of the functions of the parasympathetic and sympathetic divisions of the autonomic nervous system. Specific physiological knowledge will only be required in the context of the control of heart rate.

16.11 Homeostatic mechanisms function to maintain the body in a state of equilibrium and allow a degree of independence from the environment

Principles of homeostasis

The control of temperature and blood glucose should be used to illustrate the following principles:

- homeostasis provides a constant internal environment and independence from fluctuating external conditions;
- negative feedback tends to restore systems to their original levels;
- the possession of separate mechanisms controlling departures in different directions from the original state gives a greater degree of control;
- control mechanisms must be coordinated.

Temperature control

Mechanisms involved in heat production, conservation and loss.
The role of the hypothalamus and autonomic nervous systems in temperature control.

Control of blood glucose concentration

The factors which influence blood glucose concentration.

Role of hormones in activating enzymes involved in the interconversion of glucose and glycogen. *Details of biochemical pathways and individual enzymes are* ***not*** *required.*

The roles of insulin and glucagon in controlling blood glucose.

Diabetes and its control with insulin and by manipulation of carbohydrate intake.

16.12 Senescence is a characteristic feature of the human life-span

The decline of physiological effectiveness

The effect of age on:

- BMR;
- cardiac output;
- nerve conduction velocity.

The effect of age on reproductive function in the human female and the consequent decline in fertility.
The decrease in normal ovulatory cycles.
Changes in secretion of pituitary gonadotrophins and ovarian hormones.

17 A2 Module 8/9 (Biology [8] and Human Biology [9])

8a/9a Written Synoptic Papers

8b/9b Centre-Assessed Coursework

17.1 8a/9a Written Synoptic Papers

(see Specimen and Past Papers)

17.2 8b/9b Centre-Assessed Practical

Candidates will be assessed on the following practical skills:

A. Defining the problem.

B. Method of changing the independent variable.

C. Method of measuring the dependent variable.

D. Implementation.

E. Use of statistical techniques.

F. Interpretation of results.

G. Evaluating evidence and procedures.

This component will be marked by the teacher and moderated by AQA. For further details see Section 21.

Evidence of the skills in the shaded boxes A, B, C, E, F and G must be sent to the AQA moderator for each candidate in the sample. It is recognised that the ephemeral nature of Skill D makes it unsuitable for moderation.

Key Skills and Other Issues

18 Key Skills – Teaching, Developing and Providing Opportunities for Generating Evidence

18.1 Introduction

The Key Skills qualification requires candidates to demonstrate levels of achievement in the Key Skills of *Application of Number*, *Communication* and *Information Technology*.

The units for the 'wider' Key Skills of *Improving own Learning and Performance*, *Working with Others* and *Problem-Solving* are also available. The acquisition and demonstration of ability in these wider Key Skills is deemed highly desirable for all candidates, but they do not form part of the Key Skills qualification.

Copies of the Key Skills Units may be downloaded from the QCA Website www.qca.org.uk/keyskills

The units for each Key Skill comprise three sections:

A What you need to know.

B What you must do.

C Guidance.

Candidates following a course of study based on this specification for Biology/Human Biology can be offered opportunities to develop and generate evidence of attainment in aspects of all of the Key Skills. Areas of study and learning that can be used to encourage the acquisition and use of Key Skills, and to provide opportunities to generate evidence for Section B of the units, are signposted below. More specific guidance on integrating the delivery of Key Skills in courses based upon this specification is given in the AQA specification support material.

18.2 Key Skills Opportunities in Biology/Human Biology

This AS and A Level specification in Biology/Human Biology provides opportunities for developing and generating evidence for assessing the Key Skills listed below.

- Communication;
- Information Technology;
- Application of Number;
- Working with Others;
- Improving Own Learning and Performance;
- Problem Solving.

The broad and multi-disciplinary nature of Biology/Human Biology that calls upon candidates' abilities to demonstrate the transferability of their knowledge, understanding and skills, make it an ideal vehicle

to assist candidates to develop their knowledge and understanding of Key Skills and to produce evidence of their application

The matrices below signpost the opportunities for the acquisition, development and production of evidence for Section B of each of the Key Skills units at *Level 3*, in the teaching and learning modules of this specification. The degree of opportunity in any one module will depend upon a number of centre-specific factors, including teaching strategies and level of resources.

Communication

What you must do:		**Signposting of Opportunities for Generating Evidence in Modules**					
		1	**2/3**	**4**	**5**	**6/7**	**8/9**
C3.1a	Contribute to discussions	✓	✓	✓	✓	✓	✓
C3.1b	Make a presentation	✓	✓	✓	✓	✓	✓
C3.2	Read and synthesise information	✓	✓	✓	✓	✓	✓
C3.3	Write different types of documents	✓	✓	✓	✓	✓	✓

Application of Number

What you must do:		**Signposting of Opportunities for Generating Evidence in Modules**					
		1	**2/3**	**4**	**5**	**6/7**	**8/9**
N3.1	Plan and interpret information from different sources	✓	✓	✓	✓	✓	✓
N3.2	Carry out multi-stage calculations	✓	✓	✓	✓	✓	✓
N3.3	Present findings, explain results and justify choice of methods	✓	✓	✓	✓	✓	✓

Information Technology

What you must do:	Signposting of Opportunities for Generating Evidence in Modules					
	1	2/3	4	5	6/7	8/9
IT3.1 Plan and use different sources to search for and select information	✓	✓	✓	✓	✓	✓
IT3.2 Explore, develop and exchange information and derive new information	✓	✓	✓	✓	✓	✓
IT3.3 Present information including text, numbers and images	✓	✓	✓	✓	✓	✓

Working with Others

What you must do:	Signposting of Opportunities for Generating Evidence in Modules					
	1	2/3	4	5	6/7	8/9
WO3.1 Plan the activity	✓	✓	✓	✓	✓	✓
WO3.2 Work towards agreed objectives	✓	✓	✓	✓	✓	✓
WO3.3 Review the activity	✓	✓	✓	✓	✓	✓

Improving own Learning and Performance

What you must do:	Signposting of Opportunities for Generating Evidence in Modules					
	1	2/3	4	5	6/7	8/9
LP3.1a Agree and plan targets	✓	✓	✓	✓	✓	✓
LP3.2 Seek feedback and support	✓	✓	✓	✓	✓	✓
LP3.3 Review progress	✓	✓	✓	✓	✓	✓

Problem Solving

What you must do:		Signposting of Opportunities for Generating Evidence in Modules					
		1	2/3	4	5	6/7	8/9
PS3.1	Recognise, explain and describe the problem	✓	✓	✓	✓	✓	✓
PS3.2	Generate and compare different ways of solving problems	✓	✓	✓	✓	✓	✓
PS3.3	Plan and implement options	✓	✓	✓	✓	✓	✓
PS3.4	Agree and review approaches to tackling problems	✓	✓	✓	✓	✓	✓

NB The signposting opportunities recorded in the tables above represent the opportunities to acquire and produce evidence of the Key Skills seen to be achievable through the specification. There may be other opportunities to achieve these and other aspects of Key Skills, but these are dependent on the detailed course of study delivered within centres.

18.3 Key Skills in the Assessment of Biology/Human Biology

The 'main' Key Skills of Communication and Application of Number must contribute to the assessment of Biology/Human Biology. Aspects of Communication and Application of Number are an intrinsic part of Assessment Objectives 1, 2 and 3 and hence will form part of the assessment requirements for all units but more especially the A2 Units. In addition, in any science specification the skill of Problem Solving is an integral part of the practical component.

18.4 Further Guidance

More specific guidance and examples of tasks that can provide evidence of single Key Skills or composite tasks that can provide evidence of more than one Key Skill are given in AQA specification support material.

19 Spiritual, Moral, Ethical, Social, Cultural and Other Issues

19.1 Spiritual, Moral, Ethical, Social and Cultural Issues

The study of Biology/Human Biology contributes to candidates' understanding of spiritual, moral, ethical and cultural issues.

Opportunities for discussion of these issues are indicated in the contents of the modules.

This specification encourages candidates to appreciate the importance of all aspects of the global environment and the necessity to achieve sustainability to ensure the continuation of the human race.

Themes such as Gene Technology (Module 2, 11.4, Module 3, 12.6) Biotechnology (Module 2, 11.7, Module 3, 12.8) Pathogens and Disease (Module 3) and Ecosystems (Module 5) demonstrate the ways in which humans can help to make the global environment more stable and sustainable.

The themes of human activity (Module 5, 14.10), health and disease (Module 3), adaptations of cultivated plants and productivity (Module 2, 11.6) are linked with an understanding of the cultural differences between developed and developing countries.

In the AS Unit 4 candidates will be assessed on their ability to draw on existing knowledge to show understanding of the ethical, social, economic, environmental and technological applications of biology.

19.2 European Dimension

AQA has taken account of the 1988 Resolution of the Council of the European Community in preparing this Biology/Human Biology specification and associated specimen papers. The specification is designed to improve candidates' knowledge and understanding of the international debates surrounding new technology and to foster responsible attitudes to such developments.

19.3 Environmental Education

AQA has taken account of the 1988 Resolution of the Council of the European Community and the Report *"Environmental Responsibility: An Agenda for Further and Higher Education"* 1993 in preparing this Biology/Human Biology specification and associated specimen papers.

19.4 Avoidance of Bias

AQA has taken great care in the preparation of this specification and associated specimen papers to avoid bias of any kind.

19.5 Terminology

The terminology used in all the written papers will be that described in the Institute of Biology publication *Biological Nomenclature, Recommendation on Terms, Units and Symbols* (3rd edition 2000). The overriding consideration in setting papers will continue to be clarity and lack of ambiguity rather than adherence to strict rules; alternative names or units will be given whenever ambiguity might otherwise arise. The use in a candidate's answer of names, formulae or units other than those included in the above publication will be accepted, provided that the essential biological information is correctly supplied in the answer.

19.6 Health and Safety

An assessment of risks involved in all practical procedures must be made before work commences under the COSHH regulations. Attention is drawn to the hazards associated with many materials and processes associated with the specification. Detailed information may be found in pamphlets on safety issued by the Department for Education and Employment. In addition, all work involving live organisms must be legal and humane. It is expected that all candidates will be familiar with appropriate standards of safety in all aspects of practical work; in particular the potential hazards of microbiological work.

19.7 Mathematical Requirements

In order to be able to develop the knowledge, understanding and skills in the specification, candidates need to have been taught and to have acquired competence in the areas of mathematics set out below. Material relevant to the A Level (A2) only is given in bold type.

Arithmetic and Computation

Candidates should be able to

- 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 x^n, $1/x$, $\sqrt{x}$.

Handling data

Candidates should be able to

- use an appropriate number of significant figures;
- find arithmetic means;
- construct and interpret frequency tables and diagrams, bar charts and histograms;
- **have sufficient understanding of probability to understand how genetic ratios arise**;
- **understand the principle of sampling as applied to biological data**;
- **understand the importance of chance when interpreting data**;
- **understand the terms mean, median, mode, variance and standard deviation**;
- **use a scatter diagram to identify a correlation between two variables**;
- **use a simple statistical test (see Teachers' Guide for further guidance).**

Algebra	Candidates should be able to • change the subject of an equation; • substitute numerical values into algebraic equations using appropriate units for physical quantities.
Graphs	Candidates should be able to • 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.

Centre-Assessed Components

20

AS Module 4 *(Biology and Human Biology) Requirements and Guidance for Assessment*

This Section must be read in conjunction with the Teachers' Guide.

20.1 Introduction

In order to establish progression from GCSE to AS and from AS to A2, centre-assessed components for AS differ from those for A2. Ten individual skills are to be assessed in the context of the AS subject content. Eight of these address the four skills detailed in the section on experiment and investigation in the subject criteria for Biology. The remaining two assess the ability of candidates to select and organise relevant material in the context of demonstrating an understanding of the ethical, social, economic, environmental and technological implications and applications of biology. Coursework also provides opportunities for assessment of Key Skills (see Section 18 of this specification).

The scheme of work derived from this specification should provide opportunities for suitable practical work so that candidates can develop the necessary skills. Assessment should form part of a candidate's normal programme of coursework as opposed to a series of practical tests. Assistance in explaining the criteria on which work is to be assessed may be given by the teacher but this assistance should be generic rather than relating to the particular task under consideration.

20.2 The number of assessments required

Centres may assess each of the ten skills on more than one occasion and are required to submit the best marks obtained by the candidate for that particular group of skills. For AS, skills are assessed in the context of the groups listed below. These groups may form part of separate and discrete investigations.

20.3 Choice of tasks

The support material provides a number of suggestions for tasks that might be undertaken for assessment purposes but centres are encouraged to develop material that suits the circumstances of their staff and students. Additional help and advice is available by telephone from AQA's network of Coursework Advisers.

20.4 Group 1

Planning incorporating Skills A and B

The mark submitted for the skills in this group should be the best total mark obtained for both skills in any one single exercise.

In order to allow candidates to design experimental approaches for themselves it is essential that they are provided with a genuine opportunity to demonstrate these skills. It is therefore important that they are not provided with a situation with which they are already familiar and are merely required to alter a different variable.

As the skills in this group are experimental and investigative skills, planning should be carried out in this context and not merely as a theoretical exercise. Strategies to enable this might include providing access to sufficient materials to allow candidates to carry out pilot experiments, or to require implementation. If candidates are required to implement their plans, care must be taken that the suggested procedures are safe and ethically and environmentally acceptable. It may, therefore, be necessary for a plan to be amended before a candidate is allowed to proceed.

A plan should provide an indication of the intended experimental procedure and should therefore be written in the future tense. Formal accounts of investigations written after completion of the work are not acceptable as plans.

Planning

Within this section, candidates should:

a. identify and define the nature of a question or problem using available information and knowledge of biology;

b. choose effective and safe procedures, selecting appropriate apparatus and materials and deciding the measurements and observations likely to generate useful and reliable results;

c. consider ethical implications in the choice and treatment of organisms and the environmental and safety aspects of the proposed procedures.

SKILL Planning	PERFORMANCE LEVEL 0	1	2	3
A Method of changing the independent (manipulated) variable	Method of changing the independent variable not relevant to the problem under investigation.	Description of method of changing the independent variable relevant to the problem under consideration but would not allow implementation without considerable further detail.	Description of method of changing the independent variable relevant to the problem under consideration and would allow implementation with minor clarification of detail. Consideration given to maintaining some of the other variables constant or controlled.	Description of method of changing the independent variable relevant to the problem under consideration and would allow implementation without further detail. Consideration given to maintaining most or all of the other variables constant or controlled.
B Method of measuring the dependent variable	Method unlikely to generate useful quantitative data.	Method would generate an inadequate range of useful quantitative data.	Method would generate a full range of useful quantitative data but with some limitations concerning reliability.	Method would generate a full range of useful and reliable quantitative data.

20.5 Group 2

Implementing incorporating Skills C and D

The mark submitted for the skills in this group should be the best total mark obtained for both skills in any one single exercise.

Since the skills assessed in this group involve implementation, they should be assessed while the candidate is carrying out the practical work concerned. In order to provide appropriate opportunities to demonstrate the necessary skills, instructions provided should not be prescriptive but should allow candidates to make decisions for themselves, particularly concerning the conduct of the work and the collection of data.

A high performance level for **Skill C** should reflect the ability to work methodically and safely, demonstrating competence in the required manipulative skills and efficiency in managing time. The emphasis with **Skill D** is placed on methodical collection of raw data.
To gain maximum credit here manually collected measurements should be made to an appropriate level of accuracy and the data should be recorded logically, preferably in tabular form. If IT is used in the collection of data, the same criteria should apply.

Implementing

Within this section candidates should:

a. use apparatus and materials in an appropriate and safe way;

b. carry out work in a methodical and organised way with due regard for safety and with appropriate consideration for the well-being of living organisms and the environment;

c. make and record detailed observations in a suitable way, and make measurements to an appropriate degree of precision, using IT where appropriate.

SKILL Implementing	PERFORMANCE LEVEL			
	0	1	2	3
C Implementation of practical work	Experiment conducted in total disorder or candidate unable to use the apparatus involved.	Experiment conducted in considerable disorder with insufficient regard to safety, a failure to approach the work methodically or major failings in using apparatus.	Experiment conducted adequately but with a lack of full regard to minor aspects of safety, approach or use of apparatus.	Experiment conducted in a well organised manner. Apparatus used skilfully with full regard to safety.
D Collection and presentation of raw data	Appropriate data not collected.	Measurements not made to an appropriate level of accuracy and presented in a haphazard form.	Either measurements not made to an appropriate level of accuracy or presented in a haphazard form.	Measurements made to an appropriate level of accuracy and presented in an appropriate form.

20.6 Group 3A

Drawing incorporating Skill E

The mark submitted for this skill may be based on an independent activity.

The drawing skill assesses the ability of candidates to draw material accurately from a suitable biological specimen. Therefore photographs should not be used. The exercise may take the form of drawing a whole specimen or producing a low power tissue plan or a high power cell drawing of material seen with an optical microscope. Although candidates should be encouraged to follow the usual conventions of refraining from shading and other artistic embellishment, of labelling clearly and accurately and of adding a scale and title, it is important to note that the only skill that is assessed is that of accuracy of representation.

SKILL Analysing	PERFORMANCE LEVEL			
	0	1	2	3
E Drawing	Drawing un-representative of specimen.	Material drawn from specimen but several minor inaccuracies or a single major inaccuracy.	Material drawn from specimen with few minor inaccuracies.	Material drawn accurately from specimen.

20.7 Group 3B

Analysing, drawing conclusions and evaluating incorporating Skills F, G and H

The mark submitted for the skills in this group should be the best total mark obtained for all skills in any one single exercise. These three skills should be assessed on practical work completed by the candidate; this is particularly important in providing candidates with the opportunity to recognise the limitations of the apparatus and techniques adopted, and to be able to assess the reliability of the data collected.

Skill F requires candidates to select relevant data to produce an effective summary of the results of an investigation. An appropriate graph should be drawn and, to this end, they should be familiar with line graphs, bar charts and histograms. The conventions to be adopted are those specified in the Institute of Biology publication *"Biological Nomenclature, Recommendations on Terms, Units and Symbols" 3rd Edition (2000).*

Skill G involves the interpretation of results. Since maximum credit can only be obtained where the candidate produces an appropriate description of the trends and patterns in the data obtained and accompanies this with detailed conclusions related to biological knowledge, it is important that the task chosen offers sufficient opportunity. It is recommended that consideration be given to pooling the results of group work so that candidates are not required to spend excessive time collecting sufficient data for analysis.

The evaluation of the work in **Skill H** requires substantially more than a list of avoidable errors. Credit should only be given where candidates are able to identify the main sources of experimental error or limitations in the data collected.

Analysing evidence and drawing conclusions and evaluating

Within this section candidates should:

a. communicate biological ideas in appropriate ways, including tabulation, line graphs, histograms, continuous prose, annotated drawings and diagrams;

b. recognise and comment on trends and patterns in data;

c. draw valid conclusions by applying biological knowledge and understanding;

d. assess the reliability and precision of experimental data and the conclusions drawn from it;

e. evaluate the techniques used in the experimental activity, recognising their limitations.

SKILL Analysing	PERFORMANCE LEVEL			
	0	1	2	3
F Use of graphical techniques	Graph plotted from inappropriate data or technique selected entirely inappropriate.	Line graph, bar chart or histogram appropriately selected and relevant information plotted but major errors such as those involving scaling or accuracy of plotting.	Line graph, bar chart or histogram appropriately selected and relevant information plotted but minor errors such as those involving units or labelling.	Line graph, bar chart or histogram appropriately selected and relevant information plotted, all conventions followed and no errors apparent.
G Interpretation of results	Comment confined to translating data into continuous prose.	Trends and patterns in data recognised and described.	Trends and patterns in data recognised and described. Some valid conclusions drawn, supported by appropriate results and partly related to biological knowledge.	Trends and patterns recognised and described. Detailed conclusions drawn, fully supported by appropriate results and related to biological knowledge.
H Evaluation of practical work	Little worthwhile comment or comment confined to listings of personal failings.	Main sources of error in practical procedure identified **or** limitations of/and anomalies in results recognised.	Main sources of error in practical procedure identified **and** limitations of/and anomalies in results recognised.	Evaluation made of the influence of main sources of error in practical procedure and limitations of and anomalies in results.

20.8 Group 4

Communicating incorporating Skills I and J

The mark submitted for the skills in this group should be the best total mark obtained for both skills in any one single exercise.

The task chosen for this exercise may be a piece of written work between approximately 500 and 1000 words. Alternatively, consideration may be given to other means of presentation such as a suitably informative poster or an oral presentation. However, if tasks other than written work involving continuous prose are involved consideration needs to be given to the assessment of **Skill J**. The purpose of this exercise is to assess the specific assessment objective requiring candidates to:

> draw on existing knowledge to show understanding of the ethical, social, economic, environmental and technological applications of biology.

Tasks need, therefore, to be selected appropriately. It is visualised that this group of skills will normally be assessed during the course of teaching of either Module 2 or Module 3 which both contain appropriate subject material. Further details and suggestions appear in the support material which accompanies this specification. Candidates should be encouraged to use IT wherever possible in carrying out the assessment task.

Skill I assesses the ability to select and use appropriate information. The number of sources referred to in the criteria for the performance levels will depend on the suggested task and the resources available but stress should be placed on the range of resources used rather than the absolute number. There is no merit in confining a search for information to standard class textbooks.

Skill J is concerned with the assessment of the ability to present an argument logically and coherently and expressing ideas with appropriate scientific terminology. Spelling, punctuation and grammar should be taken into account only insofar as they affect the clarity of the argument.

Communicating

Within this section candidates should:
Select, organise and present relevant information clearly and logically, using appropriate vocabulary.

SKILL Communicating	PERFORMANCE LEVEL			
	0	1	2	3
I Selection and retrieval of appropriate information	Unable to find relevant information or found relevant information from limited number of sources but failed to use this selectively.	Found relevant information from a good range of sources but failed to use this selectively in support of an argument.	Found relevant information from a good range of sources but only used some of this selectively in support of an argument.	Found relevant information from a good range of sources and used all of this selectively in support of an argument.
J Communication of biological information	Many arguments lack clarity and logical presentation. Poor use of scientific terminology.	Most of the arguments clearly and logically presented and some use made of appropriate scientific terminology.	Arguments clearly and logically presented throughout, although not always making use of appropriate scientific terminology.	Arguments clearly and logically presented throughout. Makes use of appropriate scientific terminology throughout.

20.9 Evidence to Support the Award of Marks

Teachers are encouraged to annotate candidates' reports to help guide the moderator on their choice of the marks for each ability.

Teachers should keep records of their assessments during the course, in a form which facilitates the complete and accurate submission of the final assessments at the end of the course.

When the assessments are complete, the final marks awarded under each of the assessment criteria must be entered on the Candidate Record Form, with supporting information given in the spaces provided. A specimen Candidate Record Form appears as Appendix B.

The Candidate Record Form must be attached to the candidate's work.

21 A2 Module 8b / 9b *(Biology and Human Biology) Requirements and Guidance for Assessment*

This Section must be used in conjunction with the Teachers' Guide.

21.1 Introduction

In order to establish progression from GCSE to AS and from AS to A2, centre-assessed components for A2 differ from those for AS. Seven individual skills are to be assessed in the context of the full A Level subject content and must be assessed as *part of a single complete investigation*. They address the four skills detailed in the section on experiment and investigation in the subject criteria for Biology. Where criteria for assessment are identical to those for AS, the standard is also identical and no allowance should be made by centres for the academic maturity of the candidates concerned. The programme of coursework also provides opportunities for assessment of Key Skills (see Section 18 of this specification).

The scheme of work derived from this specification should provide opportunities for suitable practical work so that candidates can develop the necessary skills. **Skills A** and **F** involve assessment of the candidate's ability to:

> use biological skills in contexts which bring together different areas of the subject.

In order to achieve this objective, it is necessary for tasks to be set which provide the necessary opportunities. Further details and suggestions appear in the support material which accompanies this specification. Assessment should form part of a candidate's normal programme of coursework as opposed to a series of practical tests. Assistance in explaining the criteria on which work is to be assessed may be given by the teacher but this assistance should be generic rather than relating specifically to the particular task under consideration.

21.2 The number of assessments required

Centres may assess these skills on more than one occasion but are required to submit the best **set** of marks obtained by the candidate for the *complete investigation*.

21.3 Planning incorporating Skills A, B and C

In order to allow candidates to design experimental approaches for themselves it is essential that they are provided with a genuine opportunity to demonstrate these skills. It is therefore important that they are not provided with a situation with which they are already familiar and are merely required to alter a different variable.

The final report for the investigation should contain a title and an introduction. The title should provide a clear and concise definition of the problem under consideration. The introduction should draw on the candidate's biological knowledge across different areas of the specification to justify the experimental approach described in the plan which should follow this section. Title and introduction should be assessed using the criteria in **Skill A**.

The plan itself, which is assessed by **Skills B** and **C**, should provide an indication of the intended experimental procedure and should therefore be written in the future tense. Formal accounts of investigations written after completion of the work are not acceptable as plans. Assessment of the plan should take place before implementation.

Since candidates are required to implement their plans, care must be taken that the suggested procedures are safe and ethically and environmentally acceptable. It may, therefore, be necessary for a plan to be amended before a candidate is allowed to proceed.

Planning

Within this section candidates should:

a. identify and define the nature of a question or problem using available information and knowledge of biology;

b. choose effective and safe procedures, selecting appropriate apparatus and materials and deciding the measurements and observations likely to generate useful and reliable results;

c. consider ethical implications in the choice and treatment of organisms and the environmental and safety aspects of the proposed procedures.

SKILL Planning	PERFORMANCE LEVEL 0	1	2	3
A Defining the problem	Title fails to define the problem clearly and introduction provides little explanation of the experimental approach.	Title provides an indication of the problem under investigation and introduction includes some justification of the experimental approach adopted based on relevant but superficial background information.	Title provides a clear and concise definition of the problem under investigation and introduction includes some justification of the experimental approach adopted based on relevant and appropriate background biology.	Title provides a clear and concise definition of the problem under investigation and introduction includes a comprehensive justification of the experimental approach adopted based on relevant and appropriate background biology drawn from different areas of the Specification.
B Method of changing the indepen-dent (manipu-lated) variable	Method of changing the independent variable not relevant to the problem under investigation.	Description of method of changing the independent variable relevant to the problem under consideration but would not allow implementation without considerable further detail.	Description of method of changing the independent variable relevant to the problem under consideration and would allow implementation with minor clarification of detail. Consideration given to maintaining some of the other variables constant or controlled.	Description of method of changing the independent variable relevant to the problem under consideration and would allow implementation without further detail. Consideration given to maintaining most or all of the other variables constant or controlled.
C Method of measuring the dependent variable	Method unlikely to generate useful quantitative data.	Method would generate an inadequate range of useful quantitative data.	Method would generate a full range of useful quantitative data but with some limitations concerning reliability.	Method would generate a full range of useful and reliable quantitative data.

21.4 Implementation incorporating Skill D

Since this skill involves implementation, it must be assessed while the candidate is carrying out the practical work concerned. A high performance level for **Skill D** should reflect the ability to work methodically and safely, demonstrating competence in the required manipulative skills and efficiency in managing time.

It is possible for students to carry out the implementation of practical work in groups but if this strategy is adopted provision must be made for assessing individual contributions.

Within this section candidates should:

a. use apparatus and materials in an appropriate and safe way;

b. carry out work in a methodical and organised way with due regard for safety and with appropriate consideration for the well-being of living organisms and the environment;

c. make and record detailed observations in a suitable way, and make measurements to an appropriate degree of precision, using IT where appropriate.

SKILL	PERFORMANCE LEVEL			
Implementation	0	1	2	3
D Implemen-tation of practical work	Experiment conducted in total disorder or candidate unable to use the apparatus involved.	Experiment conducted in considerable disorder with insufficient regard to safety, a failure to approach the work methodically or major failings in using apparatus.	Experiment conducted adequately but with a lack of full regard to minor aspects of safety, approach or use of apparatus.	Experiment conducted in a well organised manner. Apparatus used skilfully and with full regard to safety.

21.5 Analysing evidence and drawing conclusions incorporating Skills E and F

Skill E requires the selection and use of an appropriate statistical technique (see Teachers' Guide for further guidance). Centres should be careful that the investigations undertaken by candidates allow provision for the collection of sufficient data. In some cases it may be necessary to provide additional figures to supplement those obtained by the candidate. In order to achieve the higher performance levels calculations must lead to appropriate conclusions in which candidates display their understanding of the concept of statistical significance. Further information concerning appropriate statistical tests may be found in the support material which accompanies this specification.

Skill F involves the interpretation of results. This skill involves assessment of the candidate's ability to use biological skills in contexts which bring together different areas of the subject.

Within this section candidates should:

a. communicate biological ideas in appropriate ways, including tabulation, line graphs, histograms, continuous prose, annotated drawings and diagrams;

b. recognise and comment on trends and patterns in data;

c. draw valid conclusions by applying biological knowledge and understanding.

SKILL Analysing evidence and drawing conclusions	PERFORMANCE LEVEL			
	0	1	2	3
E Use of statistical techniques	Technique selected entirely inappropriate or calculation incomplete.	Technique selected acceptable but calculation incomplete or containing such major errors that accompanying explanations are invalid.	Technique selected acceptable and calculation complete and accurate. Accompanying explanation of results incomplete or unjustified.	Technique selected acceptable and calculation complete and accurate. Accompanying explanation of results complete and justified.
F Interpre-tation of results	Comment confined to translating data into continuous prose.	Trends and patterns in data recognised and described.	Trends and patterns in data recognised and described. Some valid conclusions drawn, supported by appropriate results and partly related to biological knowledge.	Trends and patterns in data recognised and described. Detailed conclusions drawn, fully supported by appropriate results and related to biological knowledge drawn from different areas of the Specification.

21.6 Evaluating evidence and procedures incorporating Skill G

The evaluation of the work in **Skill G** requires substantially more than a list of avoidable errors. Credit should only be given where candidates are able to identify the main sources of experimental error or limitations in the data collected.

SKILL	PERFORMANCE LEVEL			
Evaluating and Communicating	0	1	2	3
G Evaluating evidence and procedures	Little worthwhile comment or comment confined to listing personal failings.	Main sources of error in practical procedure identified **or** limitations of and anomalies in results recognised.	Main sources of error in practical procedure identified **and** limitations of and anomalies in results recognised.	Evaluation made of the influence of main sources of error in practical procedure and limitations of and anomalies in results.

21.7 Evidence to Support the Award of Marks

Teachers are encouraged to annotate candidates' reports to help guide the moderator on their choice of the marks for each ability.

Teachers should keep records of their assessments during the course, in a form which facilitates the complete and accurate submission of the final assessments at the end of the course.

When the assessments are complete, the final marks awarded under each of the assessment criteria must be entered on the Candidate Record Form, with supporting information given in the spaces provided. A specimen Candidate Record Form appears as Appendix B.

The Candidate Record Form must be attached to the candidate's work.

22 Supervision and Authentication

22.1 Supervision of Candidates' Work

Candidates' work for assessment must be undertaken under conditions which allow the teacher to supervise the work and enable the work to be authenticated. If it is necessary for some assessed work to be done outside the centre, sufficient work must take place under direct supervision to allow the teacher to authenticate each candidate's whole work with confidence.

22.2 Guidance by the Teacher

The work assessed must be solely that of the candidate concerned. Any assistance given to an individual candidate which is beyond that given to the group as a whole must be recorded on the Candidate Record Form.

22.3 Unfair Practice

At the start of the course, the supervising teacher is responsible for informing candidates of the AQA Regulations concerning malpractice. Candidates must not take part in any unfair practice in the preparation of coursework to be submitted for assessment, and must understand that to present material copied directly from books or other sources without acknowledgement will be regarded as deliberate deception. Centres must report suspected malpractice to AQA. The penalties for malpractice are set out in the AQA Regulations.

22.4 Authentication of Candidates' Work

Both the candidate and the teacher are required to sign declarations confirming that the work submitted for assessment is the candidate's own. The teacher declares that the work was conducted under the specified conditions, and records the details of any additional assistance.

23 Standardisation

23.1 Standardising Meetings

Annual standardising meetings will usually be held in the autumn term. Centres entering candidates for the first time must send a representative to the meetings. Attendance is also mandatory in the following cases:

- where there has been a serious misinterpretation of the specification requirements;
- where the nature of coursework tasks set by a centre has been inappropriate;
- where a significant adjustment has been made to a centre's marks in the previous year's examination.

Otherwise attendance is at the discretion of centres. At these meetings support will be provided for centres in the development of appropriate coursework tasks and assessment procedures.

23.2 Internal Standardisation of Marking

The centre is required to standardise the assessments across different teachers and teaching groups to ensure that all candidates at the centre have been judged against the same standards. If two or more teachers are involved in marking a component, one teacher must be designated as responsible for internal standardisation. Common pieces of work must be marked on a trial basis and differences between assessments discussed at a training session in which all teachers involved must participate. The teacher responsible for standardising the marking must ensure that the training includes the use of reference and archive materials such as work from a previous year or examples provided by AQA. The centre is required to send to the moderator the Centre Declaration Sheet, duly signed to confirm that the marking of centre-assessed work at the centre has been standardised. If only one teacher has undertaken the marking, that person must sign this form.

24 Administrative Procedures

24.1 Recording Assessments

The candidates' work must be marked according to the assessment criteria set out in Sections 20 (AS) and 21 (A2). The marks and supporting information must be recorded in accordance with the instructions in Section 20.9 (AS) and Section 21.7 (A2). The completed Candidate Record Form for each candidate must be attached to the work and made available to AQA on request.

24.2 Submitting Marks and Sample Work for Moderation

The total component mark for each candidate must be submitted to AQA on the *Centre Mark Sheet* provided or by Electronic Data Interchange (EDI) by 10 January (January series) or 15 May (June series). At the same time the moderator should be sent either, the second and third copies of the *centre mark sheet*, or, for EDI centres, two copies of a printout of candidates' marks. Centres will be informed which candidates' work is required in the samples to be submitted to the moderator.

24.3 Problems with Individual Candidates

Teachers should be able to accommodate the occasional absence of candidates by ensuring that the opportunity is given for them to make up missed assessments.

Special consideration should be requested for candidates whose work has been affected by illness or other exceptional circumstances. Information about the procedure is issued separately.

If work is lost, AQA should be notified immediately of the date of the loss, how it occurred, and who was responsible for the loss. AQA will advise on the procedures to be followed in such cases.

Where special help which goes beyond normal learning support is given, AQA must be informed so that such help can be taken into account when assessment and moderation take place.

Candidates who move from one centre to another during the course sometimes present a problem for a scheme of internal assessment. Possible courses of action depend on the stage at which the move takes place. If the move occurs early in the course the new centre should take responsibility for assessment. If it occurs late in the course it may be possible to accept the assessments made at the previous centre. Centres should contact AQA at the earliest possible stage for advice about appropriate arrangements in individual cases.

24.4 Retaining Evidence and Re-Using Marks

The centre must retain the work of all candidates, with Candidate Record Form attached, under secure conditions, from the time it is assessed, to allow for the possibility of an enquiry upon result. The work may be returned to candidates after the issue of results provided that no enquiry upon result is to be made which will include re-moderation of the coursework component. If an enquiry upon result is to be made, the work must remain under secure conditions until requested by AQA.

Candidates repeating Unit 4 (BYA4) must resubmit coursework. Any new work, produced as a result of the resubmission, must be based upon different practical activities from those previously submitted. New work must provide evidence for all of the skills in the skill group(s) concerned. If, as part of the moderation process, a repeating candidate's work is included in the moderation sample, *all* of the work supporting the *new total mark* must be made available to the moderator.

Candidates repeating either unit BYA8 or BYA9 (where coursework only forms *part* of the unit) may carry forward the moderated coursework mark under the conditions outlined in the *AQA Administrative Procedures* booklet.

25 Moderation

25.1 Moderation Procedures

Moderation of the coursework is by inspection of a sample of candidates' work, sent by post from the centre to a moderator appointed by AQA. The centre marks must be submitted to AQA and the sample of work must reach the moderator by a specified date in the year in which the qualification is to be awarded.

The sample must contain evidence of the assessment of the following skills for each candidate in the sample:

AS – Skills A, B, F, G, H, I and J (not Skills C, D and E)

A2 – Skills A, B, C, E, F, and G (not Skill D)

Following the re-marking of the sample work, the moderator's marks are compared with the centre marks to determine whether any adjustment is needed in order to bring the centre's assessments into line with standards generally. In some cases it may be necessary for the moderator to call for the work of other candidates. In order to meet this possible request, centres must have available the coursework and Candidate Record Form of every candidate entered for the examination and be prepared to submit it on demand. Mark adjustments will normally preserve the centre's order of merit, but where major discrepancies are found, AQA reserves the right to alter the order of merit.

25.2 Post-Moderation Procedures

On publication of the GCE results, the centre is supplied with details of the final marks for the coursework component.

The candidates' work is returned to the centre after the examination. The centre receives a report giving feedback to the centre on the appropriateness of the tasks set, the accuracy of the assessments made, and the reasons for any adjustments to the marks.

Some candidates' work may be retained by AQA for archive purposes.

Awarding and Reporting

26 Grading, Shelf-Life and Re-Sits

26.1 Qualification Titles

The qualification based on these Specifications have the following titles:

AQA Advanced Subsidiary GCE in Biology

AQA Advanced Subsidiary GCE in Biology (Human)

AQA Advanced Level GCE in Biology

AQA Advanced Level GCE in Biology (Human)

26.2 Grading System

Both the AS and the full A Level qualifications will be graded on a five-grade scale: A, B, C, D and E. Candidates who fail to reach the minimum standard for grade E will be recorded as U (unclassified) and will not receive a qualification certificate.

Individual assessment unit results will be certificated.

26.3 Shelf-Life of Unit Results

The shelf-life of individual unit results, prior to the award of the qualification, is limited only by the shelf-life of the specification.

26.4 Assessment Unit Re-Sits

Each assessment unit may be re-sat once only. The better result will count towards the final award. Candidates may, however, re-sit the whole qualification more than once.

An AS result can be converted into a full A Level award by taking the A2 examination at any examination series when Biology/Human Biology is available.

Marks for individual AS or A2 units may be counted once only towards an AS and/or an A Level award.

26.5 Minimum Requirements

Candidates will be graded on the basis of work submitted for the award of the qualification.

26.6 Awarding and Reporting

This specification complies with the grading, awarding and certification requirements of the current *GCSE, GCE, VCE and GNVQ Code of Practice*, and will be revised in the light of any subsequent changes for future years.

Appendices

A Grade Descriptions

The following grade descriptions indicate the level of attainment characteristic of the given grade at A Level. They give a general indication of the required learning outcomes at each specific grade. The descriptors should be interpreted in relation to the content outlined in the specification; they are not designed to define that content.

The grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives (as in Section 6) overall. Shortcomings in some aspects of the examination may be balanced by better performances in others.

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

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

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

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

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

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

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

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

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

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

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

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

B

Coursework Record Forms

AQA
ASSESSMENT and QUALIFICATIONS ALLIANCE

Centre-assessed work
Candidate Record Form
Series/Year

AS Biology /Biology (Human) BYA4

Centre Name ..... **Centre No.** | | | | | |

Candidate Name ..... **Candidate No.** | | | | |

This side is to be completed by the candidate

Sources of advice and information

1. Have you received any help or information from anyone other than your subject teacher(s) in the production of this work? ..... (Write YES or NO)

2. If you have answered YES, give details. Continue on a separate sheet if necessary.

.....

3. If you have used **any** books, information leaflets or other materials (e.g. videos, software packages or information from the Internet) to help you complete this work, you must list these below unless they are clearly acknowledged in the work itself. To present material copied from books or other sources without acknowledgement will be regarded as deliberate deception.

.....

.....

NOTICE TO CANDIDATE

The work you submit for assessment must be your own.

If you copy from someone else or allow another candidate to copy from you, or if you cheat in any other way, you may be disqualified from at least the subject concerned.

Declaration by candidate

I have read and understood the **Notice to Candidates** (above). I have produced the attached work without any help apart from that which I have stated on this sheet.

Signed ..... Date .....
(Candidate)

This form should be completed and attached to the candidate's work and retained at the Centre or sent to the moderator as required.

This side is to be completed by the teacher.

Marks must be awarded in accordance with the instructions and criteria in section 20 of the specification.

Supporting information to show how the marks have been awarded should be given [in the form of annotations on the candidate's work / in the spaces provided below].

Investigation title(s)

Please complete the boxes to show the marks awarded and use the spaces to make any summative comments which seem appropriate.

Criteria for award of marks	Max. Mark	Mark awarded	Teacher's supporting statement
A Changing independent variable	3		
B Measuring dependent variable	3		
C Conducting practical work	3		
D Collecting raw data	3		
E Drawing	3		
F Graphical techniques	3		
G Interpreting results	3		
H Evaluating	3		
I Selecting information	3		
J Communicating	3		

Total	30	

Evidence of the shaded Skills A, B, F, G, H, I and J must be sent to the AQA moderator for each candidate in the sample.

Concluding Comments

Details of additional assistance given (if any)
Record here details of any assistance given to this candidate which is beyond that given to the class as a whole and beyond that described in the specification. Continue on a separate sheet if necessary.

Teacher's signature ..... Date .....

ASSESSMENT and QUALIFICATIONS ALLIANCE

Centre-assessed work Candidate Record Form Series/Year

A2 Biology /Biology (Human) BY89/2

Centre Name ..... **Centre No.** | | | | | |

Candidate Name ..... **Candidate No.** | | | | |

This side is to be completed by the candidate

Sources of advice and information

1. Have you received any help or information from anyone other than your subject teacher(s) in the production of this work? ..... (Write YES or NO)

2. If you have answered YES, give details. Continue on a separate sheet if necessary.

.....

3. If you have used **any** books, information leaflets or other materials (e.g. videos, software packages or information from the Internet) to help you complete this work, you must list these below unless they are clearly acknowledged in the work itself. To present material copied from books or other sources without acknowledgement will be regarded as deliberate deception.

.....

.....

NOTICE TO CANDIDATE

The work you submit for assessment must be your own.

If you copy from someone else or allow another candidate to copy from you, or if you cheat in any other way, you may be disqualified from at least the subject concerned.

Declaration by candidate

I have read and understood the **Notice to Candidates** (above). I have produced the attached work without any help apart from that which I have stated on this sheet.

Signed ..... Date .....
(Candidate)

This form should be completed and attached to the candidate's work and retained at the Centre or sent to the moderator as required.

This side is to be completed by the teacher.

Marks must be awarded in accordance with the instructions and criteria in section 21 of the specification.

Supporting information to show how the marks have been awarded should be given [in the form of annotations on the candidate's work / in the spaces provided below].

Investigation title

Please complete the boxes to show the marks awarded and use the spaces to make any summative comments which seem appropriate.

Criteria for award of marks	**Max. Mark**	**Mark awarded**	**Teacher's supporting statement**
A Defining problem	3		
B Changing independent variable	3		
C Measuring dependent variable	3		
D Implementing	3		
E Statistical techniques	3		
F Interpretating results	3		
G Evaluating	3		

Total	21	

Evidence of the shaded Skills A, B, C, E, F and G must be sent to the AQA moderator for each candidate in the sample.

Concluding Comments

Details of additional assistance given (if any)
Record here details of any assistance given to this candidate which is beyond that given to the class as a whole and beyond that described in the specification. Continue on a separate sheet if necessary.

Teacher's signature ..... Date .....

AQA
ASSESSMENT and QUALIFICATIONS ALLIANCE

Centre-assessed work

Centre Declaration Sheet

Series/Year

Qualification [please tick]: GCE ☐ AVCE ☐ GNVQ ☐ Key Skills ☐ FSMU ☐

Specification Title: .....

Unit Code(s): ..... Centre No: ☐☐☐☐☐

Centre Name: .....

Authentication of candidates' work

This is to certify that marks have been awarded in accordance with the requirements of the specification and that every reasonable step has been taken to ensure that the work presented is that of the candidates named. Any assistance given to candidates beyond that given to the class as a whole and beyond that described in the specification has been recorded on the Candidate Record Form(s) and has been taken into account. The marks given reflect accurately the unaided achievement of the candidates.

Signature(s) of teacher(s) responsible for assessment **Date:** .....

Teacher 1 ..... Teacher 2 .....

Teacher 3 ..... Teacher 4 .....

Teacher 5 ..... Teacher 6 .....

(continue overleaf if necessary)

Internal standardisation of marking

Each centre must standardise the assessments across different teacher/assessors and teaching groups to ensure that all candidates at the centre have been judged against the same standards. If two or more teacher/assessors are involved in marking, one of them must be designated as responsible for standardising the assessments of all teacher/assessors at the centre.

The teacher/assessor responsible for ensuring standardisation must sign declaration (a).
If all the work has been marked by the same person, that person must sign declaration (b).

I confirm that *[please tick either (a) or (b)]*

☐ **(a) the procedure described in the specification has been followed at this centre to ensure that the assessments are of the same standard for all candidates; or**

☐ **(b) I have marked the work of all candidates.**

Signed: ..... **Date:** .....

Signature of Head of Centre: ..... Date: .....

This form should be completed and sent or given to the moderator with the sample of centre-assessed work.

C

Overlaps with other Qualifications

GCE Biology

The Subject Criteria for Biology require that all GCE Biology specifications will have at least fifty percentage overlap in content with each other but the depth of treatment of each topic and the assessment pattern will ensure that each specification is distinctive.

GCE Science

The following topics receive some coverage on both specifications:

Cell Structure
Photosynthesis and Respiration
Ecosystems
Nutrient Cycles
Evolution and Biodiversity
Biological Molecules
Reproduction and Inheritance
Adaptation to the Environment
Genes and Genetic Engineering

GCE Environmental Science

Topics which occur in both specifications include:

Ecosystems
Nutrient cycles
Nutrition
Genetic Engineering
Deforestation

The approach, breadth and depth of coverage of these topics varies between the specifications.

GCE Chemistry

Some aspects of biochemistry will be covered in both specifications, for example the structure of organic molecules, bonding, and the action of enzymes.

GCE (AS) Science for Public Understanding

The following topics are covered to varying depths in both specifications:

Infectious Diseases
Genetic Diseases
Genetic Engineering
Evolution

AVCE Science (Single and Full Award)	The following compulsory AVCE units for both Single and Full Award display some overlap: **AVCE Unit 2:** 'Monitoring the Activity of the Human Body' includes the structure and function of the cardiovascular and pulmonary systems, cellular respiration and temperature control. **AVCE Unit 5:** (Full Award only) 'Synthesising Organic and Biochemical Compounds' includes the structure of organic molecules, enzymes and their use in industrial processes and the principles of genetic engineering. **AVCE Unit 6**: 'Carrying out scientific investigations'
Other Level 3 Qualifications	There are no other Level 3 Qualifications for which there is any significant overlap with this specification.