Version 1.0 Date 05/06

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Biology 5416/6416
Specification B
2008

Material accompanying this Specification

- Past Papers and Mark Schemes
- Reports on the Examination
- Teachers' Guide

SPECIFICATION

This specification will be published annually on the AQA Website (www.aqa.org.uk). If there are any changes to the specification centres will be notified in print as well as on the Website. The version on the Website is the definitive version of the specification.

Further copies of this specification booklet are available from:

AQA Logistics Centre, Unit 2, Wheel Forge Way, Ashburton Park, Trafford Park, Manchester, M17 1EH.
Telephone: 0870 410 1036 Fax: 0161 953 1177
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can be downloaded from the AQA Website: www.aqa.org.uk

Set and published by the Assessment and Qualifications Alliance.

The Assessment and Qualifications Alliance (AQA) is a company limited by guarantee registered in England and Wales 3644723 and a registered charity number 1073334.
Registered address AQA, Devas Street, Manchester, M15 6EX. *Dr Michael Cresswell Director General.*

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Background Information

1 Advanced Subsidiary and Advanced Level Specifications

1.1 Advanced Subsidiary (AS)

Advanced Subsidiary courses 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 are modular. The AS comprises three teaching and learning modules and the A2 comprises a further three teaching and learning modules. Each teaching and learning module is normally 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 by the end of the second year;
- 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

AS Examination 5416

Unit 1 Core Principles

1 hour — 30% of the total AS mark
15% of the total A Level mark

Structured test

Unit 2 Genes and Genetic Engineering

1 hour — 30% of the total AS mark
15% of the total A Level mark

Structured test

Unit 3(a) Physiology and Transport	Unit 3 (b) Coursework
1 hour	
25% of the total AS marks *12.5% of the total A Level mark*	15% of the total AS marks *7.5% of the total A Level mark*
Structured test	Centre-assessed Coursework

Advanced Subsidiary Award

5416

+

A2 Examination 6416

Unit 4 Energy, Control and Continuity

1½ hours — *15% of the total A Level mark*

Structured test

Unit 5 (a) Environment	Unit 5 (b) Coursework
1¼ hours	
7.5% of the total A Level mark *(inc. 3.5% synoptic)*	*7.5% of the total A Level mark* *(inc. 2.5% synoptic)*
Structured test	Centre-assessed Coursework

Either Unit 6 or Unit 7 or Unit 8

2¼ hours

Section A — *10% of the total A Level mark*
Structured test — *(inc. 4% synoptic)*

Unit 6 Applied Ecology
Unit 7 Microbes and Disease
Unit 8 Behaviour and Population

Section B — *10% synoptic of the total A Level mark*

Units 6, 7, 8 — Applying Biological Principles

Essay and data-handling questions from Modules 1-5

Advanced Award

6416

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	BYB4 and BYB5	✓	✓
June	All	All	✓	✓

3.2 Sequencing of Units

It is recommended that AS (1, 2 and 3) units are studied before A2 units (4, 5 and 6/7/8.)

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 - BYB1 Unit 2 - BYB2 Unit 3 - BYB3	Unit 4 - BYB4 Unit 7 - BYB7 Unit 5 - BYB5 Unit 8 - BYB8 Unit 6 - BYB6

The **Subject Code** for entry to the AS only award is 5416

The **Subject Code** for entry to the Advanced Level award is 6416

3.4 Classification Codes

Candidates entering for this examination are prohibited from entering for any GCE Biology and Human Biology specifications in the same series with any awarding body. This does not preclude candidates from taking AS and A2 units in the same specification with AQA in the same examination series. Candidates may not take AS in one specification and A2 from a different specification.
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.

3.5 Private Candidates

This specification is available to private candidates. Private candidates should write to the Entries Section at AQA for a copy of *Supplementary Guidance for Private Candidates*.

All private candidates are required to complete the *Private Candidate Coursework Information Form*, at the back of the *Supplementary Guidance for Private Candidates* booklet and to submit this form to the Examinations Officer at the accommodating centre when the entry is made. Private candidates submitting coursework must also complete a *Private Candidate Assessment Form* which must be attached to the coursework when it is submitted to the Examinations Officer at the accommodating centre.

3.6 Access Arrangements and Special Consideration

AQA pays due regard to the provisions of the Disability Discrimination Act 1995 in its administration of this specification.

Arrangements may be made to enable candidates with disabilities or other difficulties to access the assessment. An example of an access arrangement is the production of a Braille paper for a candidate with a visual impairment. Special consideration may be requested for candidates whose work has been affected by illness or other exceptional circumstances.

Further details can be found in the Joint Council for Qualifications (JCQ) document:
Access Arrangements and Special Consideration
Regulations and Guidance Relating to Candidates who are Eligible for Adjustments in Examination
GCE, AEA, VCE, GCSE, GNVQ, Entry Level & Key Skills
This document can be viewed via the AQA web site (www.aqa.org.uk)

Applications for access arrangements and special consideration should be submitted to AQA by the Examinations Officer at the centre.

3.7 Language of Examinations

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

Scheme of Assessment

4 Introduction

4.1 Rationale

This GCE Biology Specification complies with:

- the Subject Criteria for Biology;
- the *GCSE, GCSE in vocational subjects, GCE, VCE, GNVQ and AEA Code of Practice 2006/7*;
- 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.

This qualification is a recognised part of the National Qualifications framework. As such AS and Advanced GCE provide progression from Key Stage 4, through post-16 studies to form the basis for entry to higher education and employment.

4.2 Specifications A and B

AQA has developed two specifications, A and B, 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.

Specification A was modelled on the AEB syllabus and offers a Biology or Human Biology route through the AS and A Level.

4.3 Specification B

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

Specification B has been designed to encourage candidates to develop essential knowledge and understanding of concepts of Biology, an understanding of scientific methods, an awareness of advances in technology, a recognition of the value of biology in society and to appreciate the relationship between different aspects of the subject. The specification was developed to meet the requirements of Advanced Subsidiary and Advanced Level Subject Criteria for Biology, published by QCA in March 1999. These requirements necessitated significant reorganisation of the knowledge, understanding and skills in the previous syllabus. The Subject Criteria dictate certain areas of biology which are to be covered in the

Advanced Subsidiary specification and others that must be covered in the Advanced (A2) specification. The criteria offer freedom to include certain topics in either specification, notably the study of ecosystems. In order to provide coherence in the study of ecology, all the criteria relating to ecosystems are contained in a single module in the A2 specification, 'Environment'. This allows centres maximum

flexibility to undertake supportive fieldwork at an appropriate and convenient time in a two-year course. The relationship of the modular content to the Subject Criteria is outlined in the introduction to each module. The knowledge, understanding and skills in the Subject Criteria must comprise about 50% of the AS and about 50% of the A level specification.

4.4 Features

Features of the syllabus include:

- detailed amplification of the expected knowledge, understanding and skills required. Where candidates are expected to develop specific skills, the following phrase is used, 'Candidates should be able to …'. The content described in Sections 9 to 15 forms a complete statement of the depth of treatment and technical terminology that may be assessed in written tests;
- an element of choice of topics in the A2 specification. The three optional modules (6 or 7 or 8) allow candidates to pursue a more specialised area of biology in greater depth according to their particular interests. The optional modules are based on distinctive topics which proved particularly popular in the previous syllabuses;
- an AS specification which establishes core principles on which an understanding of biology is based, and at the same time covers relevant topics in sufficient depth to form coherent modules for students who may not continue their study of biology to Advanced level;
- emphasis on the application of biology in understanding currently rapidly developing fields, such as biotechnology, medicine, food production and environmental protection;
- opportunities to evaluate the ethical use of biological knowledge and to demonstrate an appreciation of the value of biological understanding;
- criteria for the assessment of investigations which meet the requirements of the Subject Criteria and build on established good practice;
- assessment of understanding of scientific methods in written papers in order to encourage broader development of the skills inherent in investigation.

4.5 Prior level of attainment and recommended prior learning

This GCE Biology specification builds on the knowledge, understanding and skills set out in the National Curriculum Key Stage 4 Programme of Study for Double Science. The specification provides opportunities for candidates to develop further their Key Stage 4 biological knowledge, understanding and skills with certification giving access to higher education, employment and general career development.

5 Aims

5.1 AS and A level specifications in biology should encourage students to:

- develop essential knowledge and understanding of concepts of biology, and the skills needed for the use of these in new and changing situations;
- develop an understanding of scientific methods;
- be aware of advances in technology, including information technology, relevant to biology;
- recognise the value and responsible use of biology in society;
- sustain and develop their enjoyment of, and interest in, biology.

5.2 In addition, A level specifications in biology should encourage students to:

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

6 Assessment Objectives (AOs)

The 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.

Knowledge, understanding and skills are closely linked. This specification requires that all candidates demonstrate the following assessment objectives in the context of the content and skills prescribed.

6.1 AO1 Knowledge with understanding

Candidates should be able to:

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

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

Candidates should be able to:

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

6.3 AO3 Experiment and investigation

Candidates should be able to:

- devise and plan experimental and investigative activities, selecting appropriate techniques;
- demonstrate safe and skilful practical techniques;
- make observations and measurements with appropriate precision and record these methodically;

- interpret, explain, evaluate and communicate the results of their experimental and investigative activities clearly and logically using biological knowledge and understanding and using appropriate specialist vocabulary.

6.4 A04 Synthesis of knowledge, understanding and skills

Candidates should be able to:

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

6.5 Quality of written communication

The quality of written communication is assessed in all assessment units where candidates are required to produce extended written material. In Units 1, 2, 4 and 5(a), one mark is available for quality of written communication. In Unit 6/7/8 three marks are available for quality of written communication. In Units 3 (b) and 5 (b) quality of written communication is addressed within Skill C: Analysing evidence and drawing conclusions.

Candidates will be assessed according to their ability 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 where 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 four 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.

7.1 Assessment Units

Unit 1	Written Paper	1 hour
30% of the total AS marks	*54 marks*	

This unit comprises a structured test which assesses Module 1, Core Principles. All questions are compulsory.

Unit 2	Written Paper	1 hour
30% of the total AS marks	*54 marks*	

This unit comprises a structured test which assesses Module 2, Genes and Genetic Engineering. All questions are compulsory.

Unit 3 (a)	Written Paper	1 hour
25% of the total AS marks	*54 marks*	

This unit comprises a structured test which assesses Module 3 (a), Physiology and Transport. All questions are compulsory.

Unit 3 (b)	Coursework
15% of the total AS marks	*30 marks*

This centre-assessed component requires teachers to assess candidates' performance in four skill areas based on practical investigations. External moderation by inspection. Further details are given in Sections 18 – 24.

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**	
AO1 Knowledge with understanding	18	18	15	51
AO2 Application of knowledge and understanding, analysis and evaluation	12	12	10	34
AO3 Experiment and investigation	-	-	15	15
Overall Weighting of Units (%)	30	30	40	100

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.

8.1 AS Assessment Units

Unit 1 15% of the total A Level marks	Written Paper 54 marks	1 hour
Unit 2 15% of the total A Level marks	Written Paper 54 marks	1 hour
Unit 3 (a) 12.5% of the total A Level marks	Written Paper 54 marks	1 hour
Unit 3 (b) 7.5% of the total A Level marks	Coursework 30 marks	

8.2 A2 Assessment Units

Unit 4 *15% of the total A Level marks*	Written Paper *81 marks*	1½ hours

This unit comprises a structured test which assesses Module 4, Energy, Control and Continuity. All questions are compulsory.

Unit 5 (a) *7.5% of the total A Level marks*	Written Paper *66 marks*	1¼ hours

This unit comprises a structured test which assesses Module 5(a), Environment, and includes synoptic assessment (3.5%). All questions are compulsory.

Unit 5 (b) *7.5% of the total A Level marks*	Coursework *38 marks*	

This centre-assessed component requires teachers to assess candidates' performance in four skill areas based on one practical investigation and includes an element of synoptic assessment (2.5%). External moderation by inspection. Further details are given in Sections 18 - 24.

Unit 6	Written Paper	2¼ hours
20% of the total A Level marks	*100 marks*	

The written paper for this unit comprises Sections A and B. Section A is a structured test which assesses Module 6, Applied Ecology (6%) including a synoptic element (4%). All questions in the structured test are compulsory. Section B, Applying Biological Principles, comprises structured data questions and a choice of one from two essay questions. All questions are synoptic (10%) requiring knowledge, understanding and skills from Modules 1 to 5.

OR

Unit 7	Written Paper	2¼ hours
20% of the total A Level marks	*100 marks*	

The written paper for this unit comprises Sections A and B. Section A is a structured test which assesses Module 7, Microbes and Disease (6%) including a synoptic element (4%). All questions in the structured test are compulsory. Section B, Applying Biological Principles, comprises structured data questions and a choice of one from two essay questions. All questions are synoptic (10%) requiring knowledge, understanding and skills from Modules 1 to 5.

OR

Unit 8	Written Paper	2¼ hours
20% of the total A Level marks	*100 marks*	

The written paper for this unit comprises Sections A and B. Section A is a structured test which assesses Module 8, Behaviour and Populations (6%) including a synoptic element (4%). All questions in the structured test are compulsory. Section B, Applying Biological Principles, comprises structured data questions and a choice of one from two essay questions. All questions are synoptic (10%) requiring knowledge, understanding and skills from Modules 1 to 5.

8.3 Synoptic Assessment

The Advanced Subsidiary and Advanced Level Criteria state that A Level specifications must include synoptic assessment (representing at least 20% of the total A Level marks). The criteria for synoptic assessment (Assessment Objective AO4) are given in Section 6.4.

Marks for synoptic assessment are allocated as follows:

Assessment Unit 5 – 6%, assigned:

Written Paper – 3.5%. Synoptic questions will require candidates to bring together knowledge and understanding developed in Module 5 with principles and concepts derived from Modules 1 to 4. Candidates will be expected to use ideas and skills which permeate biology.

Experiment and Investigation coursework - 2.5%. Candidates are required to use their overall knowledge and understanding of biological principles and concepts when planning the assessed investigation and when analysing and drawing conclusions from the results.

Assessment Units 6 or 7 or 8 – 14%, assigned:

Written paper, Section A – 4%. Each option test (Section A of the paper) will contain synoptic questions which require candidates to bring together knowledge and understanding developed in the option module 6 or 7 or 8 with principles and concepts derived from Modules 1 to 5. Candidates will be expected to use ideas and skills which permeate biology.

Written paper, Section B – 10%. Section B is a common section taken by all candidates. It comprises structured data questions and an essay. The essay question requires candidates to use knowledge and understanding from Modules 1 to 5. The data questions require candidates to apply principles and skills developed during the study of Modules 1 to 5, and to show an understanding of the broad principles of experimental investigation developed through study of Assessment Objective AO3. Questions relating to synoptic assessment of AO3 have a weighting of approximately 2.5%.

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	
AO1 Knowledge with understanding	9.0	9.0	7.5	6.5	2.5	3.5	38.0
AO2 Application of knowledge and understanding, analysis and evaluation	6.0	6.0	5.0	8.5	1.5	2.5	29.5
AO3 Experiment and investigation	-	-	7.5	-	5.0	-	12.5
AO4 Synthesis of knowledge understanding and skills	-	-	-	-	6.0	14.0	20.0
Overall Weighting of Units (%)	15	15	20	15	15	20	100

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

Subject Content

9 Summary of Subject Content

9.1 AS Modules

MODULE 1 – Core Principles

Biological molecules.
Cells.
Cell transport.
Organisms exchange materials with their environment.
Enzymes.
Digestion.

MODULE 2 – Genes and Genetic Engineering

The genetic code.
The cell cycle.
Sexual reproduction.
Applications of gene technology.

MODULE 3 (a) – Physiology and Transport

Transport systems.
The control of breathing and heartbeat.
Energy and exercise.
The transport of substances in plants.

MODULE 3 (b) – AS Coursework

Centre-based assessment of practical investigations (See Sections 18-24).

9.2 A2 Modules

MODULE 4 – Energy, Control and Continuity

Energy supply.
Photosynthesis.
Respiration.
Survival and coordination.
Homeostasis.
Nervous coordination.
Analysis and integration.
Muscles are effectors which enable movement to be carried out.
Inheritance.
Variation.
Selection and evolution.
Classification.

MODULE 5 (a) – Environment

Energy flow through ecosystems.
Materials are recycled in ecosystems.
Studying ecosystems.
Dynamics of ecosystems.
Human activities can impose far-reaching effects on the environment.

MODULE 5 (b) – Coursework

Centre-based assessment of a practical investigation (see Sections 18-24).

MODULE 6 – Applied Ecology

Diversity.
Effects of pollution on diversity.
Organisms show structural, physiological and behavioural adaptations for survival in a given niche.
Agricultural ecosystems.
Harvesting from a natural ecosystem.
Conservation.

OR

MODULE 7 – Microbes and Disease

Bacteria.
Culturing bacteria.
Commercial biotechnology.
Bacterial disease.
Viral disease.
Protection against disease.

OR

MODULE 8 – Behaviour and Populations

Patterns of behaviour.
Reproductive behaviour.
Pregnancy.
Human growth and development.
Human populations and health.

MODULES 6, 7 and 8 – Applying Biological Principles

Section B of Unit written papers for Modules 6, 7 and 8 assesses synopsis of the content of Modules 1 – 5.

10

AS Module 1
CORE PRINCIPLES

Introduction

This module lays emphasis on concepts which are essential for more advanced understanding of living organisms. All organisms are composed of compounds whose molecules are based on a small number of chemical elements. These biologically important compounds frequently consist of monomers combined into polymers. Organisms are organised on a cellular basis, and cells are differentiated according to function. Cells, and whole organisms, exchange materials with their environment. The biological processes that are essential for the functioning of organisms are regulated by the action of enzymes. The study of enzymes is extended to include digestion. The gas exchange and the digestive systems are explored in the context of adaptation to function. It is expected that the emphasis in this module will be on these fundamental principles, and that there will also be adequate opportunity for candidates to undertake work related to the development of experimental and investigative skills.
This module includes part of the knowledge and understanding specified in the mandatory subject criteria for Advanced Subsidiary Biology, as set out in the document issued by QCA in June 1999. It covers sections 3.5, 3.6, 3.7, 3.9 and 3.11 of that document.

10.1 Biological molecules

Carbohydrates

The elements which make up carbohydrates. Monosaccharides are the basic molecular units (monomers) of which other carbohydrates are composed; they include the reducing sugars glucose and fructose.

The condensation of glucose to form the disaccharide, maltose, and of glucose and fructose to form the disaccharide, sucrose (a non-reducing sugar).

The formation of the polysaccharides starch, glycogen and cellulose.

Hydrolysis of disaccharides and polysaccharides.

Relationship of structure to function in starch, glycogen and cellulose molecules.

Proteins

The elements which make up proteins. Amino acids are the monomers of which proteins are composed.

The condensation of amino acids to form dipeptides, polypeptides and proteins. Hydrolysis of proteins.

The primary, secondary and tertiary structures of proteins. The relationship of structure to function in fibrous and globular proteins.

Lipids

The elements which make up lipids (fats and oils).

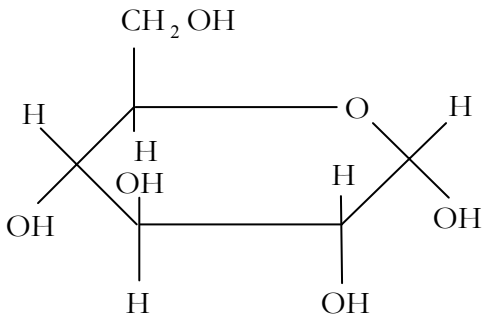
Glycerol and fatty acids combine by condensation to produce triglycerides.

The R group of a fatty acid may be saturated or unsaturated.

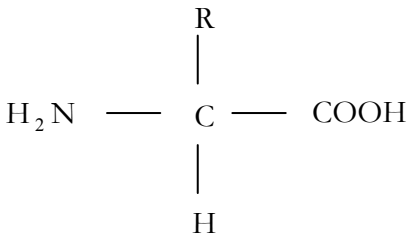
In phospholipids, one of the fatty acids of a triglyceride is substituted by a phosphate group.

Structural formulae

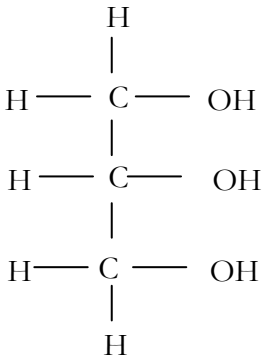
The structural formula of glucose is:



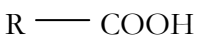
The structural formula of an amino acid is:



The structural formula of glycerol is:



The structural formula of a fatty acid is:



Candidates should be able to use the above structural formulae, and others that may be given, to explain the processes of condensation and hydrolysis.

Biochemical tests

The identification of reducing and non-reducing sugars, starch, proteins and lipids by means of simple biochemical tests, using Benedict's solution, iodine solution, the biuret test and the emulsion test.

Chromatography	The separation and identification of compounds by means of chromatography, including Rf values and two-way chromatography.
Water	The biological importance of water as a solvent and as a medium for living organisms, including change of state and specific heat capacity.

10.2 Cells

Cell structure	The structure of an epithelial cell from the small intestine and a palisade mesophyll cell from a plant, as seen with a light microscope. The ultrastructure of eukaryotic cells and their organelles, to include cell wall, cell membrane, nucleus, mitochondrion, chloroplast, rough and smooth endoplasmic reticulum, Golgi body and ribosome. Functions of these organelles.
Prokaryotic and eukaryotic cells	The ultrastructure of a typical bacterial cell, to include cell wall, cell membrane, genetic material, ribosomes, flagellum, plasmid, capsule. Comparison of prokaryotic and eukaryotic cells.
Electron microscopy and differential centrifugation	The use of electron microscopy and differential centrifugation as means of investigating cell structure and function. **Candidates should be able to** recognise the organelles in cells in electron micrographs.
Cell differentiation	The cells of multicellular organisms may differentiate and become adapted for specific functions. Tissues as aggregations of similar cells, and organs as structures performing specific physiological functions. **Candidates should be able to** describe and explain the adaptations of epithelial cells from the small intestine and of palisade mesophyll cells, and to use examples from the human digestive system to illustrate the features of tissues and organs.

10.3 Cell transport

Plasma membranes	The entry and exit of substances is controlled by the cell surface membrane and by other plasma membranes within cells. The fluid-mosaic model of plasma membrane structure. The function of proteins in membranes as receptors and carriers. The relationship between membrane structure and the ability of membranes to control the movement of substances through them.
Diffusion	Diffusion as the passive movement of substances in the direction of a concentration gradient. The effect of surface area and distance on the rate of diffusion. The role of carrier and channel proteins in facilitated diffusion.
Osmosis	Osmosis as a special case of diffusion across a partially permeable membrane, net movement of water depending on difference in water potentials. Hypotonic, hypertonic and isotonic solutions, and the importance of ion concentrations in maintaining cell turgor.

Active transport	Active transport as the movement of molecules or ions through a membrane by carrier proteins against a concentration gradient, and as a process requiring the transfer of energy.

10.4 Organisms exchange materials with their environment

Surface area: volume ratio	The relationship between the size of an organism or structure and the surface area: volume ratio, and the significance of this for the exchange of substances and of heat. Changes to body shape and the development of systems in larger organisms as adaptations to facilitate exchanges as the ratio reduces.
Gaseous exchange	The development of internal gas exchange surfaces in larger organisms to maintain adequate rates of exchange. The structure, location and adaptation for function of the gas exchange surfaces and related structures in: dicotyledonous plant leaves (mesophyll and stomata); bony fish (gill lamellae and filaments, including the countercurrent principle); mammals (alveoli, bronchioles, bronchi, trachea, lungs).
Ventilation	Organisms with internal gas exchange surfaces need mechanisms for conveying gases between the environment and these surfaces. The ventilation systems, related to the environment in which they live, in bony fish and mammals.

10.5 Enzymes

Action of enzymes	Biological processes are regulated by the action of enzymes. Enzymes as proteins which act as catalysts. The importance of enzymes in lowering activation energy so that the chemical reactions necessary to support life can proceed sufficiently quickly and within an acceptable temperature range. The mode of action of enzymes in terms of the formation of an enzyme-substrate complex.
Enzyme properties	The properties of enzymes related to their tertiary structure. The effects of change in temperature, pH, substrate concentration, and competitive and non-competitive inhibition on the rate of enzyme action.

10.6 Digestion

Extracellular digestion	Extracellular digestion exemplified by a saprophytic fungus. The principles of the use of starch-agar plates for assaying carbohydrase activity.
Digestion in humans	The generalised structure of the human gut wall. **Candidates should be able to** relate the generalised structure of the gut wall in the oesophagus, stomach, duodenum and ileum to the functions of these organs.

The sites of production and action of:

- amylases;
- endopeptidases;
- exopeptidases;
- lipase;
- maltase;
- bile.

Mechanisms for the absorption of food by the ileum, including the roles of diffusion, facilitated diffusion and active transport.

11

AS Module 2
GENES AND GENETIC ENGINEERING

Introduction

This module explores some of the ways in which the understanding of genes that has been developed over the past half century is being applied. Elucidation of the structure and functions of nucleic acids has helped to explain how genes incorporate coded information which determines the nature of organisms, and how, during the cell cycle and sexual reproduction, genetic information is copied and passed on. The development of techniques for manipulating and transferring genes has opened up opportunities to use microorganisms to synthesise biological compounds on a large scale, to enhance food production and to introduce treatments for human genetic disorders. Candidates are expected to understand the basis of these developments and to explore the practical and ethical issues associated with them.

This module includes part of the knowledge and understanding specified in the mandatory subject criteria for Advanced Subsidiary Biology, as set out in the document issued by QCA in June 1999. It covers sections 3.14, 3.15 and part of 3.16 of that document.

11.1 The genetic code

The gene

Genes are sections of DNA which contain coded information that determines the nature and development of organisms.
A gene can exist in different forms called alleles which are positioned in the same relative position (locus) on homologous chromosomes.

Structure of DNA

DNA is a stable polynucleotide.

The double helix structure of the DNA molecule in terms of:

- the components of DNA nucleotides;
- the sugar-phosphate backbone;
- specific base pairing and hydrogen bonding between polynucleotide strands (only simple diagrams of DNA structure are needed; structural formulae are not required).

Replication of DNA

The semi-conservative mechanism of DNA replication, including the role of DNA polymerase.

The genetic code

How DNA acts as a genetic code by controlling the sequence of amino acids in a polypeptide.

Codons for amino acids are triplets of nucleotide bases.

Role of nucleic acids in protein and enzyme synthesis

The structure of RNA.

The production of mRNA in transcription, and the role of RNA polymerase.
The roles of ribosomes, mRNA and its codons, and tRNA and its anticodons in translation.

Candidates should be able to explain:

- how the structures of DNA and RNA are related to their functions;
- the relationship between genes, proteins and enzymes.

Mutation

New forms of alleles arise from changes (mutations) in existing alleles.

Gene mutation as the result of a change in the sequence of bases in DNA, to include addition, deletion and substitution.

Mutations occur naturally at random. High energy radiation, high energy particles and some chemicals are mutagenic agents.

Candidates should be able to explain:

- how a change in the sequence of bases in an individual gene may result in a change in the amino acid sequence in the polypeptide;
- how the resulting change in polypeptide structure may alter the way the protein functions;
- how, as a result of mutation, enzymes may function less efficiently or not at all, causing a metabolic block to occur in a metabolic pathway.

11.2 The cell cycle

Mitosis

During mitosis DNA replicates in the parent cell, which divides to produce two new cells, each containing an exact copy of the DNA of the parent cell. Mitosis increases cell number in this way in growth and tissue repair and in asexual reproduction.

Candidates should be able to name and explain the stages of mitosis and recognise each stage from diagrams and photographs.

Applications of cloning

Genetically identical organisms (clones) can be produced by using vegetative propagation, and by the splitting of embryos.

Given appropriate information, candidates should be able to explain the principles involved in:

- producing crops by vegetative propagation;
- the cloning of animals by splitting apart the cells of developing embryos.

11.3 Sexual reproduction

Gametes and fertilisation

Sexual reproduction involves gamete formation and fertilisation. In sexual reproduction DNA from one generation is passed to the next by gametes.

Differences between male and female gametes in terms of structure, size, number produced and mobility.

Meiosis

During meiosis, cells containing pairs of homologous chromosomes divide to produce gametes containing one chromosome from each homologous pair.

In meiosis the number of chromosomes is reduced from the diploid number (2n) to the haploid number (n).
(Details of meiosis not required.)

Importance of meiosis	When gametes fuse at fertilisation to form a zygote the diploid number is restored. This enables a constant chromosome number to be maintained from generation to generation. **Candidates should be able to** interpret life cycles of organisms in terms of mitosis, meiosis, fertilisation and chromosome number.

11.4 Applications of gene technology

Principles of genetic Engineering	In genetic engineering, genes are taken from one organism and inserted into another. The use of restriction endonuclease enzymes to extract the relevant section of DNA. The use of ligase enzyme to join this DNA into the DNA of another organism.
The polymerase chain reaction	The process of DNA replication can be made to occur artificially and repeatedly in a laboratory process called the polymerase chain reaction (PCR). The use of PCR, radioactive labelling and electrophoresis to determine the sequence of nucleotides in DNA.
Genetically engineered microorganisms	Microorganisms are widely used as recipient cells during gene transfer. Plasmids are often used as vectors to incorporate selected genes into bacterial cells. Rapid reproduction of microorganisms enables a transferred gene to be cloned, producing many copies of the gene.
Genetic markers	Genetic markers in plasmids, such as genes which confer antibiotic resistance, and replica plating may be used to detect the bacterial cells that contain genetically engineered plasmids.
Large scale culturing	Bacteria containing the transferred gene can be cultured on a large scale in industrial fermenters. Useful substances produced by using genetically engineered microorganisms include antibiotics, hormones and enzymes. (Details of manufacturing processes not required.)
Gene therapy and cystic fibrosis	In gene therapy healthy genes may be cloned and used to replace defective genes. In cystic fibrosis the transmembrane regulator protein, CFTR, is defective. A mutant of the gene that produces CFTR results in CFTR with one missing amino acid. The symptoms of cystic fibrosis related to the malfunctioning of CFTR. Techniques that might possibly be used to introduce healthy CFTR genes into lung epithelial cells include: • use of a harmless virus into which the CFTR gene has been inserted; • wrapping the gene in lipid molecules that can pass through the membranes of lung cells.

Genetically modified animals	How animals can be genetically engineered to produce substances useful in treating human diseases, as exemplified by genetically engineering sheep to produce alpha-1-antitrypsin which is used to treat emphysema and cystic fibrosis.
Evaluation of genetic engineering	**Candidates should be able to** evaluate the ethical, social and economic issues involved in the use of genetic engineering in medicine and in food production.

12

AS Module 3 (a)
PHYSIOLOGY AND TRANSPORT

Introduction

This module concentrates on mass transport systems in mammals and flowering plants. It builds on principles established in Module 1 and explores how substances are transported to and from exchange surfaces. In addition to the study of the human blood system, work on exercise is included to explain how human systems are adapted for differing demands on the body. Candidates should thereby acquire an overview of the range of processes involved and be able to relate their understanding to everyday experience. In studying transport in plants there is emphasis on structural and physiological adaptations of plants for survival in unfavourable environmental conditions. There is also the opportunity to evaluate evidence in a topic where understanding is still incomplete and thus to develop understanding of scientific investigation.

This module includes part of the knowledge and understanding specified in the mandatory subject criteria for Advanced Subsidiary Biology, as set out in the document issued by QCA in June 1999. It covers sections 3.10 and 3.11 of that document.

12.1 Transport systems

Mass transport

Over large distances in organisms, efficient supply of materials is provided by mass transport (the bulk movement of substances through transport systems).

The transport systems of larger organisms are intimately linked with specialised exchange systems, whose main function is to maintain concentration gradients.

Mammalian heart

The structure and function of the heart, including the atria and ventricles, atrioventricular and semilunar valves. The cardiac cycle related to the maintenance of blood flow through the heart.

Candidates should be able to relate pressure and volume changes in the heart and aorta to events in the cardiac cycle.

Blood vessels

The structure of arteries, arterioles, veins and capillaries related to their functions.

Exchange of materials

The main substances transported by the blood system, and the sites at which exchange occurs.

The loading, transport and unloading of oxygen in relation to the oxygen haemoglobin dissociation curve, and the effects of pH and carbon dioxide concentration.

Tissue fluid

The relationship between blood, tissue fluid, lymph and plasma.

The role of the lymph system in the return of tissue fluid to the blood system.

12.2 The control of breathing and heartbeat

Control of ventilation	The role of the medulla in the brain and of the stretch receptors in the lungs in the maintenance of breathing.
	The role of the medulla in the brain and of the receptors in the lungs, aortic bodies and carotid bodies in the response of the breathing system to increased muscular activity.
Control of heartbeat	The role of the sinoatrial node, the atrioventricular node and the bundle of His in the maintenance of the heartbeat.
	The role of the medulla, pressure receptors and chemoreceptors in the walls of the aorta and carotid sinuses in the response of the heart to increased muscular activity.

12.3 Energy and exercise

Energy sources	Glucose, glycogen and triglycerides as sources of energy for muscle contraction.
	ATP as the immediate energy source.
	Comparison of aerobic and anaerobic respiration as sources of ATP for muscle contraction, in terms of amounts of energy produced and products. (Biochemical details of pathways are **not** required.)
Muscle fatigue	Muscle fatigue in terms of increase in blood lactate and decrease in blood pH.
	The fate of lactate.

12.4 The transport of substances in plants

Root structure	Structure of a primary root, to include root hairs, endodermis, xylem and phloem. The distribution of these tissues and their adaptations for function.
Uptake and the transpiration stream	Uptake of water and ions from the soil. Pathway of transport of water from root hairs to stomata, including apoplast and symplast pathways in the root.
	Transpiration, and the effects of light, temperature, humidity and air movement.
	The roles of root pressure and cohesion–tension in moving water through the xylem.
Xerophytes	Structural adaptations that reduce the rate of transpiration in xerophytic plants, related to survival in dry conditions.
Translocation	Phloem as the tissue that transports organic substances. The mass flow hypothesis for the mechanism of translocation in plants.
Experimental evidence	The use of radioactive tracers and ringing experiments to determine the movement of ions and organic substances through plants. **Candidates should be able to** interpret evidence from tracer and ringing experiments and to evaluate the evidence for and against the mass flow hypothesis.

12

AS Module 3 (b) *COURSEWORK*

Candidates will be assessed on the following four practical skills taken from one or more practical investigations based on the AS Subject Content of Modules 1 to 3(a).

A. Planning

B. Implementing

C. Analysing evidence and drawing conclusions

D. Evaluating evidence and procedures.

This component will be marked by the teacher and moderated by the Awarding Body.

For further details, see Sections 18-24.

13

A2 Module 4
ENERGY, CONTROL AND CONTINUITY

Introduction

In this module the central role of ATP as the immediate provider of energy for metabolic processes is covered. The biochemistry of photosynthesis and respiration are studied in order to enable understanding of how ATP is generated and how biological compounds are synthesised. This module extends the work on physiology and genetics that was undertaken in the Advanced Subsidiary modules. It considers the ability of organisms to survive by maintaining a constant internal environment and responding to changes in the external environment. As well as studying examples of homeostasis, candidates survey a complete account of nervous communication from the stimulation of receptors, formation of nerve impulses and integration in the central nervous system to the response of effectors in the form of muscle contraction. The module explores how continuity of species is maintained by the transmission of genetic information from generation to generation, and how selection and evolution can account for the diversity of living organisms. The principles by which species are classified into groups using shared derived features are also covered.

This module covers part of the knowledge and understanding specified in the mandatory subject criteria for Part 2 (A2) of an Advanced Level Biology syllabus, as set out in the document issued by QCA in June 1999. It covers sections 3.8, 3.13, 3.16, 3.17 and 3.18 of that document.

13.1 Energy supply

The relationship between photosynthesis and respiration

Photosynthesis as a process in which light energy is used in the synthesis of organic molecules.

Respiration as the process by which energy in organic molecules is made available for other processes within an organism.

ATP

The synthesis of ATP from ADP and inorganic phosphate, and its role as the immediate source of energy for biological processes.

13.2 Photosynthesis

Light-dependent reaction

The light-dependent reaction only in sufficient detail to show that:

- light energy excites electrons in chlorophyll;
- the energy from these excited electrons is used to generate ATP and reduced NADP;
- photolysis of water makes hydrogen available for the light-independent reaction and gaseous oxygen is released.

Light-independent reaction	The light-independent reaction only in sufficient detail to show that: • carbon dioxide is accepted by ribulose bisphosphate to form two molecules of glycerate 3-phosphate; • ATP and reduced NADP are required for the reduction of glycerate 3-phosphate to carbohydrate; • ribulose bisphosphate is regenerated.
Chloroplast structure	The structure and role of chloroplasts in relation to photosynthesis.

13.3 Respiration

Glycolysis and Krebs cycle	The biochemistry of aerobic respiration only in sufficient detail to show that: • glycolysis involves the oxidation of glucose to pyruvate with a net gain of ATP and reduced NAD; • pyruvate combines with coenzyme A to produce acetylcoenzyme A; • acetylcoenzyme A is effectively a two-carbon molecule which combines with a four-carbon molecule to produce a six-carbon molecule which enters Krebs cycle; • Krebs cycle involves a series of oxidation reactions and the release of carbon dioxide leading to the production of ATP and reduced coenzyme (NAD or FAD); • synthesis of ATP is associated with the electron transport chain.
Mitochondria	The structure and role of mitochondria in respiration.

13.4 Survival and coordination

Stimulus and response	Organisms increase their chances of survival by responding to changes in their environment. Information is transferred in the nervous system through detection of stimuli by receptors and the initiation of a nerve impulse, leading to an associated response by effectors by means of a coordinator. A simple reflex arc involving three neurones. Information is transferred by hormones released by endocrine glands and affecting the physiological activities of target cells.

13.5 Homeostasis

Homeostasis	Physiological control systems operate in mammals to maintain the internal environment within restricted limits – this is homeostasis.
Negative feedback	The principle of negative feedback and its role in restoring systems to their original levels.
Regulation of body temperature	The processes involved in thermoregulation in a mammal, including the role of thermoreceptors in the skin and the hypothalamus.
Regulation of blood glucose	The role of insulin and glucagon in the control of blood glucose, including the importance of specific membrane receptors and their effect on enzyme-controlled reactions. The conversion of glucose to glycogen for storage.

Removal of metabolic waste	Waste products of metabolism are frequently toxic and must be removed from the body. Deamination of excess amino acids and the production of urea. (Details of the ornithine cycle **not** required.)
	The processes involved in the formation of urine in the kidney, including ultrafiltration in the renal capsule and selective reabsorption in the proximal convoluted tubule.
Regulation of blood water potential	The role of the loop of Henle in maintaining a gradient of ions across the medulla. The role of ADH in the regulation of blood water content by the distal convoluted tubule and the collecting duct.
	The importance of the ionic gradient in regulating blood water potential.

13.6 Nervous coordination

The mammalian eye	The structure and function of the iris in controlling the amount of light which enters the eye.
	The roles of the cornea, lens, ciliary muscles and suspensory ligaments in focusing an image on the retina.
Rods and cones	The structure of rods and cones.
	The photosensitive bleaching of rhodopsin in rods.
	The trichromatic theory of colour vision as an explanation of the functioning of cones.
	Differences in sensitivity and visual acuity as explained by differences in the distribution of rods and cones and the connections they make with neurones in the optic nerve.
The nerve impulse	The structure of a myelinated motor neurone.
	The establishment of a resting potential in terms of the differential membrane permeability and the presence of cation pumps.
	The initiation of an action potential and its all-or-nothing nature, explained by changes in membrane permeability leading to depolarisation.
	The passage of an action potential along non-myelinated and myelinated axons resulting in nerve impulses.
	The nature and importance of the refractory period in producing discrete nerve impulses.
Synapses and synaptic transmission	The detailed structure of a synapse as revealed by an electron microscope.
	The sequence of events involved in the action of a cholinergic synapse and a neuromuscular junction.
Drugs and synapses	The effect of drugs on synaptic transmission.
	When provided with information, candidates should be able to predict and explain the effects of specific drugs on a synapse. (Candidates will not be required to recall the effects of individual drugs.)

13.7 Analysis and integration

The brain and cerebral hemispheres

The principal functions of the cerebral hemispheres:

- the role of sensory areas in receiving input from receptors and motor areas controlling effectors;
- the relationship between the size of the relevant part of the cerebral hemispheres and the complexity of innervation;
- the control of one side of the body by the opposite hemisphere;
- the role of association areas in interpreting sensory input as illustrated by the visual association area;
- the location and role of areas of the cerebral hemispheres associated with speech.

The autonomic nervous system

The general role of the sympathetic and parasympathetic components of the autonomic nervous system.

The specific effects of the autonomic nervous system in controlling:

- pupil diameter and tear production in the eye;
- the emptying of the bladder.

13.8 Muscles are effectors which enable movement to be carried out

Antagonistic muscle action

Candidates should be able to explain examples of movement in terms of antagonistic muscle action.

Muscle structure

The structure of skeletal muscle as seen with light and electron microscopes.

The relationship between the structure of a sarcomere and the distribution of actin and myosin.

Muscle contraction

The sliding filament hypothesis of muscle contraction.

The role of tropomyosin, calcium ions and ATP in the cycle of actin/ myosin cross bridge formation.

Candidates should be able to relate the mechanism of muscle contraction to the appearance of a sarcomere in a contracted or a relaxed state.

13.9 Inheritance

Genotype

The genotype is the genetic constitution of an organism.

The expression of this genetic constitution and its interaction with the environment is the phenotype.

The alleles at a specific locus may be either homozygous or heterozygous. Alleles may be dominant, recessive or codominant.

There may be multiple alleles of a single gene.

Meiosis and fertilisation

The principal events associated with meiosis, to include:

- pairing by homologous chromosomes;
- formation of bivalents;
- chiasma formation and exchange between chromatids;
- separation of chromatids;
- production of haploid cells.

	Candidates should be able to explain: the behaviour of alleles and homologous chromosomes during meiosis and fertilisation, i.e. independent assortment during meiosis and random recombination during fertilisation; the random movement of non-homologous chromosomes and their genes. (Details and names of individual stages of meiosis are **not** required.)
Sex determination	The genetic basis of sex determination.
Monohybrid and dihybrid inheritance	**Candidates should be able to** apply the above principles to interpret and use fully annotated genetic diagrams to predict the results of: • monohybrid crosses involving dominant, recessive and codominant alleles; • crosses involving sex-linked characteristics; • dihybrid crosses, including epistasis. (Predictions involving linkage on autosomes are **not** required.)

13.10 Variation

Types of variation	Variation between individuals may be either continuous or discontinuous.
Causes of variation	Similarities and differences between individuals within a species may be the result of genetic factors, differences in environmental factors, or a combination of both. **Candidates should be able to** interpret data to determine the relative effects of genetic and environmental factors involved in continuous and discontinuous variation. **Candidates should be able to** explain how crossing over, independent assortment of chromosomes, random fusion of gametes and mutation contribute to genetic variation.

13.11 Selection and evolution

Natural selection	Individuals within a species may show a wide range of variation. Predation, disease and competition result in differential survival and reproduction. Those organisms with a selective advantage are more likely to survive, reproduce and pass on their genes to the next generation. **Candidates should be able to:** • use specific examples to explain how natural selection produces changes within a species; • interpret data and use unfamiliar information to explain how natural selection produces change within a population.

Speciation	The concept of the species in terms of production of fertile offspring. **Candidates should be able to explain:** • how natural selection and isolation may result in changes in the allele and phenotype frequency and lead to the formation of a new species; • how evolutionary change over a long period of time has resulted in a great diversity of forms among living organisms.

13.12 Classification

Principles of taxonomy	The principles and importance of taxonomy. A classification system comprises a hierarchy in which groups are contained within larger composite groups with no overlap. The phylogenetic groupings are based on patterns of evolutionary history.
The five kingdoms	One hierarchy comprises Kingdom, Phylum, Class, Order, Family, Genus, Species. The distinguishing features of the five kingdoms – prokaryotes, protoctists, fungi, plants and animals.

14

A2 Module 5 (a) *ENVIRONMENT*

Introduction

Consideration is given in this module to the important principles underlying the maintenance of ecosystems, including energy flow and nutrient cycles, the dynamics and stability of ecosystems and the effects of human activity. Candidates are expected to undertake some investigative work on an ecosystem, and this may provide an opportunity to carry out an investigation in which statistical analysis is applied, thus matching the requirements of the A2 coursework submission. It is also intended that candidates will be able to bring to bear a broad understanding of biological principles when studying organisms in the environment, and that they will have had more time to carry out fieldwork than if assessment were to take place in the Advanced Subsidiary course.

This module covers part of the knowledge and understanding specified in the mandatory subject criteria for Part 2 (A2) of an Advanced Level Biology syllabus as set out in the document issued by QCA in June 1999. It covers sections 3, 3.19, 3.20 and 3.21 of that document.

14.1 Energy flow through ecosystems

Energy transfer

Photosynthesis is the major route by which energy enters an ecosystem. Energy is transferred through the trophic levels in food chains and food webs and is dissipated.

Quantitative consideration of the efficiency of energy transfer between trophic levels.

Ecological pyramids

The relationship of pyramids of number, biomass and energy to their corresponding food chains and webs.

14.2 Materials are recycled in ecosystems

Nutrient cycles

Complex organic molecules are broken down in an ecosystem by microorganisms. Carbon dioxide and inorganic ions are thus made available for re-use.

The role of microorganisms in the carbon and nitrogen cycles in sufficient detail to illustrate the processes of saprophytic nutrition, deamination, nitrification, nitrogen fixation and denitrification. (Names of individual species **not** required.)

14.3 Studying ecosystems

Ecological techniques

Candidates should have studied an ecosystem in the field and be familiar with the uses, roles and limitations of frame quadrats and line transects, and with the measurement of abiotic factors, including pH, light and temperature.

Candidates should understand the principles involved in the use of standard deviation and the chi-squared test in reporting the results of ecological studies.

14.4 Dynamics of ecosystems

Ecosystems

A population is all the organisms of one species in a habitat.
Populations of different species form communities.
These communities are found in a particular habitat and are based on dynamic feeding relationships.
Within a habitat a species occupies a niche governed by adaptation to food availability and/or prevailing abiotic conditions.

Stability of populations

An ecosystem supports a certain size of population of any one species.
This population size may vary as a result of:
the effect of abiotic factors;
interactions between organisms;
inter- and intra-specific competition;
predation.

Succession and climax communities

In natural and suitable conditions land will gradually become colonised by a range of herbaceous plants, then by shrubs and finally by trees as a climax community.

There is change in the communities with time, because of the interaction between species and their environment. At each stage certain species can be recognised which change the environment so that it becomes more suitable for other species.

Candidates should be able to describe one example of succession.

14.5 Human activities can impose far-reaching effects on the environment

Ecological impact of farming

The impact of monoculture and the removal of hedgerows on the environment.

The effects of organic effluent, nitrates and phosphates on aquatic ecosystems, including eutrophication and effects on biochemical oxygen demand.

Pesticide toxicity

Biodegradable and non-biodegradable pesticides. The bioaccumulation of pesticides in food webs.

Balance of food production and conservation

Candidates should be able to describe and explain how farms may be managed in ways that help to ensure sustainability and reduce the impact on wildlife, such as the use of organic fertilisers, prevention of erosion, control of pesticide use and maintenance of habitat variety.

When provided with appropriate information, candidates should be able to evaluate evidence and make balanced judgements between the need to meet the demands for increased food production by agriculture and the need to conserve the environment.

14

A2 Module 5 (b) *COURSEWORK*

Candidates will be assessed on the following five practical skills taken from one practical investigation based on the A Level Subject Content of Modules 1 to 6 and including opportunities for a statistical test:

A. Planning
B. Implementing
C. Analysing evidence and drawing conclusions
D. Evaluating evidence and procedures
E. Synthesis of principles and concepts.

This component will be marked by a teacher and moderated by the Awarding Body.

For further details, see Sections 18-24.

15

A2 Option Module 6
APPLIED ECOLOGY

Introduction

This option module provides the opportunity for candidates to pursue their study of the basic ecological principles covered in Module 5 to much greater depth. It is anticipated that candidates will be able to spend more time on fieldwork and become familiar with a broader range of techniques. It is hoped that the use of aquatic ecosystems to provide examples for the study of diversity and pollution will mean that suitable habitats are accessible for candidates. Candidates are required to apply their understanding of ecological principles to agriculture and crop production, and to contrast this with harvesting fish from a natural ecosystem. The importance of quantitative data in the scientific study of populations and diversity is emphasised throughout.

In the assessment of this module a knowledge and understanding of relevant content from Modules 1 to 5 will be assumed.

15.1 Diversity

Sampling techniques

Candidates should have studied both natural and artificial ecosystems in the field and be familiar with the use of the following techniques for collecting data:

- frame and point quadrats;
- line and belt transects;
- netting and trapping;
- mark-release-recapture.

Candidates should be familiar with ways of ensuring that sampling is random.

Diversity index

Calculation and interpretation of an index of diversity from the formula

$$d = \frac{N(N-1)}{\Sigma n(n-1)}$$

where N = total number of organisms of all species
and n = total number of organisms of each species.

Methods of collecting data in a suitable form for calculation of this index of diversity.

Abiotic and biotic factors

In an ecosystem biotic and abiotic factors interact.

Candidates should be able to explain and apply the following principles:

- the difference between abiotic and biotic factors;
- abiotic factors exert a density-independent effect on populations;
- biotic factors exert a density-dependent effect on populations;
- abiotic factors vary throughout a particular habitat to produce microclimates which are important in determining the distribution of different species.

Stability of ecosystems	**Candidates should be able to explain** and apply the following basic principles: • The diversity of organisms in extreme environments is usually low. Abiotic factors dominate distribution and abundance. A low diversity results in an unstable ecosystem susceptible to change; • The diversity of organisms in physically less hostile environments is usually high. Biotic factors dominate distribution and abundance. A high diversity confers stability on an ecosystem; • During the course of ecological succession the physical environment becomes less hostile and diversity increases.

15.2 Effects of pollution on diversity

Pollution of aquatic ecosystems	The use of diversity indices and indicator species in monitoring freshwater pollution. (The effects of organic effluents on aquatic ecosystems – section 14.5) The effects of heavy metal ions from industrial effluent on aquatic organisms, and the principles underlying their toxicity. Lethal concentration and lethal dose as methods of assessing toxicity. Persistence and potential for accumulation of heavy metal ions in food webs. The effects of acid rain on aquatic organisms, resulting from the release of aluminium ions and precipitation of phosphates. The sources of sulphur dioxide and nitrogen oxide emissions, and how they contribute to acid rain. The effects of crude oil spillages on aquatic organisms.

15.3 Organisms show structural, physiological and behavioural adaptations for survival in a given niche

Structural adaptation	The relationship between body size and shape of mammals and reptiles and climatic temperature. The structural adaptations of plants which allow them to survive in deserts where water supplies are limited, and to tolerate high salt concentrations.
Physiological adaptation	Water balance in desert-living rodents. The factors that enable the kidneys of these animals to produce concentrated urine. An outline of C4 photosynthesis, emphasising its advantages to tropical plants. (Biochemical details are **not** required.)
Behavioural adaptation	The summer and winter patterns of migration to and from Britain by birds. The environmental factors which control the timing of migration. The advantages of migration. The essential features of taxes and kineses. The importance of these forms of behaviour in enabling animals to remain in a favourable environment.

15.4 Agricultural ecosystems

Agricultural ecosystems	Comparison of natural ecosystems and those resulting from modern intensive farming in terms of energy input, productivity, and species and genetic diversity.
Quantitative basis of crop production	Net productivity as defined by the expression: • Net productivity = Gross productivity – Respiratory loss. The ways in which productivity is affected by: • efficiency of energy conversion; • leaf area index.
Crop rotation and fertilisers	The biological principles underlying the use of crop rotation and the benefits of incorporating leguminous plants. The use of natural and artificial fertilizers, including the 'law of diminishing returns'.
Abiotic factors and productivity	The principle of limiting factors as applied to the effects of temperature, carbon dioxide concentration and light intensity on the rate of photosynthesis. The enhancement of these factors in glasshouses. **Candidates should be able to** evaluate economic issues involved with the enhancement of these factors.
Chemical control of weeds and insects	The use of contact and systemic herbicides in the control of weeds. The use of auxins as selective weedkillers. The issues associated with the use of insecticides: • toxicity; • persistence; • specificity; • their potential for accumulation in food webs.
Biological control	The principles involved in biological control of pests. The advantages of integrating chemical and biological approaches to pest control. **Candidates should be able to evaluate** the effects of modern intensive farming, including the use of fertilisers, herbicides, pesticides and biological control.

15.5 Harvesting from a natural ecosystem

Fisheries	Fishing as an example of harvesting from a natural ecosystem. The relationship between productivity and maximum sustainable yield in fisheries.
Regulation	The regulation of fishing by: • net size restrictions; • quotas; • close seasons; • exclusion zones.

Fish farming	Open and closed systems. The advantages of fish farming. The effects of fish farming on other organisms. **Candidates should be able to** evaluate information relating to the use of natural ecosystems as sources of food.

15.6 Conservation

Conservation principles	The principles underlying: • species conservation: the protection of rare species; • nature conservation: the preservation of sites of special scientific interest; • biological conservation: maintaining the diversity of living organisms within habitats; • environmental conservation: conserving the abiotic characteristics of ecosystems; • global conservation: conserving the composition of the atmosphere and oceans. **Candidates should be able to** describe one example of each of the above types of conservation.

15

A2 Option Module 7
MICROBES AND DISEASE

Introduction

This option module provides for a study in depth of some of the ways in which microorganisms are used in the rapidly expanding field of biotechnology, and how pathogenic microbes cause disease. The principles involved in culturing microorganisms and obtaining useful products from them provide opportunities for practical experience of basic microbiological techniques. It is essential that all Health and Safety procedures are followed. As well as covering the transmission and effects of bacterial and viral pathogens, the module includes a study of how both natural defence systems and medical treatments can be used to combat disease.

In the assessment of this module a knowledge and understanding of relevant content from Modules 1 to 5 will be assumed.

15.7 Bacteria

Structure and function

Characteristic features of bacteria, (including cell wall, cell membrane, nuclear zone, 70S ribosomes, mesosomes, flagella, plasmids and capsule – as listed in Section 10.2) and the major functions of these structures.

Nutrition and binary fission

Bacteria may obtain energy from sunlight, inorganic substances or from organic substances. (Details of processes not required.)

Binary fission as the main method of reproduction.

15.8 Culturing bacteria

Aseptic techniques

Aseptic techniques and health and safety procedures in handling, culturing and disposing of bacteria.

Monitoring the growth of bacteria

The techniques of haemocytometry, turbidimetry and dilution plating. The distinction between total and viable counts.

Population growth pattern

Typical growth curve of a bacterial population and reasons for lag phase, exponential phase, stationary phase and death phase.

Effect of temperature, pH, nutrient availability and oxygen availability on growth.

Use of a bacterial lawn as a bioassay technique to determine the effectiveness of antibiotics and disinfectants on inhibition of bacterial growth.

Candidates should be able to analyse and interpret experimental data from microbial growth investigations.

15.9 Commercial biotechnology

Screening procedures	The advantages of using microorganisms for industrial processes. Screening procedures are carried out to identify the most suitable microorganisms to use for a particular process; for example, fungi can be screened for antibiotic production and casein can be used to identify protease production by bacteria.
Continuous and batch cultures	The relative advantages and disadvantages of continuous and batch culturing techniques.
Useful products from microorganisms	The microorganisms used and the main stages in the production of penicillin. Downstream processing is carried out to extract and purify the end-product of fermentation. **Candidates should be able to** use information provided to explain the purpose of various parts of industrial fermenters and the stages involved in biotechnological processes.
Isolated enzymes	It is more efficient to use isolated enzymes than whole cells because enzyme concentration is higher and there are no unwanted enzymes present.
Immobilised enzymes	Isolated enzymes can be immobilised so that they do not contaminate the end-products and can be used over and over again. Immobilisation can be achieved by bonding the enzyme with a cross-linking agent, entrapment inside a gel, and by binding the enzyme on to the surface of an adsorbing agent.

15.10 Bacterial disease

Pathogenicity	The factors affecting pathogenicity of bacteria, to include: • features of cell wall and capsule that affect attachment and entry to host cells; • exotoxins and endotoxins produced by bacteria; • infectivity, exemplified by numbers required to cause *Salmonella* food poisoning and typhoid fever; • invasiveness, the ability of bacteria to spread within the host.
Transmission	Food-borne and water-borne infection, exemplified by *Salmonella* food poisoning and *E.coli*. Precautions to avoid contamination of food and water. Human carriers. Treatment of diarrhoea.

15.11 Viral disease

Characteristics of viruses	The structural features of a virus, exemplified by the influenza virus and HIV.
Transmission	The course of infection, signs, symptoms and transmission of influenza and of acquired immune deficiency syndrome (AIDS). The process of replication of the influenza virus and of the human immunodeficiency virus (HIV).

How viruses cause disease	Damage to host cells due to viral replication. How HIV causes AIDS. Reasons for the difficulty in treating viral infections. **Candidates should be able to** suggest strategies for reducing the incidence of influenza and preventing the spread of HIV.

15.12 Protection against disease

Natural defence mechanisms	The roles of the skin, tears, mucus, saliva and cilia in preventing microorganisms gaining access to living cells. The process of phagocytosis and the roles of phagocytic white blood cells (neutrophils and macrophages) in destroying, and preventing the spread of, microorganisms that enter the blood and other tissues.
The immune response	Antigens, as substances that are 'foreign' to the individual organism exposed to them. They usually take the form of a protein, polysaccharide or glycoprotein structure: • on the cell surface of a microorganism; • on the surface of a virus; • on the cell surface of a tissue or organ transplant; • as a free molecule, such as a toxin.
Cell-mediated immunity	Production of T lymphocytes in bone marrow and activation by the thymus. Recognition of antigens by specific, membrane-bound receptor molecules on T lymphocytes. Cloning of T lymphocytes, and destruction of bacteria and cells with antigens.
Antibody-mediated immunity	Production of B lymphocytes, and activation by antigens attached to macrophage membrane. Cloning of B lymphocytes, and production of specific antibodies. Antibody structure, and formation of antibody-antigen complex. The role of antibodies in: • agglutination of antigens; • stimulation of phagocytosis; • precipitation of soluble toxins; • preventing pathogenic bacteria attaching to cell membranes.
Immunological memory	The production of memory T cells and B cells. The primary and secondary responses. The role of immunological memory in producing a quicker and stronger immune response to a subsequent infection by the same antigen. The effects of antigenic variability in some pathogens, such as influenza virus, on immunity.
Vaccination	The principle that vaccines contain antigens derived from pathogens, which can protect against infection by that organism. The principles involved in the production of, and the method of administering, the following types of vaccine: • killed virulent organisms, exemplified by whooping cough; • live non-virulent strains, exemplified by rubella; • modified toxins, exemplified by diphtheria; • isolated antigens from a pathogen, exemplified by influenza; • genetically engineered antigens, exemplified by hepatitis B.

Passive immunity	The use of antibodies to counteract possible infection, and the reason for its temporary effectiveness. Natural passive immunity in young babies.
Antibiotics	The mode of action of antibiotics in the treatment of diseases caused by bacteria and fungi. Effects of antibiotics on cell walls and membranes, and on nucleic acid and protein synthesis. The principle of selection of particular antibiotics for treatment of specific diseases, and the roles of broad spectrum and narrow spectrum antibiotics.
Antibiotic resistance	The process by which an antibiotic resistant strain of bacterium may develop. Transfer of resistance genes between bacteria. Mechanisms of resistance, such as the production of penicillinase. The impact of resistant strains on the treatment of disease and the use of antibiotics.

15

A2 Option Module 8
BEHAVIOUR AND POPULATIONS

Introduction

This option module extends the study of nervous and hormonal physiology in Module 4 to the behaviour of whole organisms. There is also consideration of reproductive behaviour and human growth and development, with an emphasis on the underlying principles of hormonal control. The study of human populations is developed to include a range of public health issues. Candidates are expected to understand the biological background to these issues and to be able to evaluate possible strategies for improvement.

In the assessment of this module a knowledge and understanding of relevant content from Modules 1 to 5 will be assumed.

15.13 Patterns of behaviour

Innate behaviour

The principal differences between innate and learned behaviour.

Taxes and kineses

Taxes and kineses as examples of innate behaviour.

Reflex actions

The nature of simple reflex behaviour, such as in reflex escape responses.

The linking of a number of simple reflexes to produce a more complex pattern of behaviour as shown by the reflexes involved in the feeding of a new-born human infant.

Modified reflexes

The modification of reflex behaviour by learning as shown by the development of conscious control of bladder emptying.

Learned behaviour

Habituation and imprinting.

Classical conditioning, illustrated by the work of Pavlov on the control of salivation in dogs.

Operant conditioning, illustrated by the work of Skinner on rats.

The importance of reinforcement stimuli and rewards in learning .

Candidates should be able to explain examples of behaviour in terms of classical conditioning and of operant conditioning and to evaluate parallels between animal and human behaviour.

15.14 Reproductive behaviour

Courtship

Courtship behaviour as a necessary precursor to successful mating. The roles of species recognition, pair bond formation, sexual selection and synchronisation of breeding behaviour.

Sign stimuli and innate releaser mechanisms as components in simple courtship patterns.

The role of hormones and pheromones in courtship behaviour.

Candidates should be able to analyse individual components in simple courtship patterns, and evaluate comparisons between the behaviour of humans and other animals.

Territorial behaviour	The advantages of defending a territory, in relation to breeding success.
The menstrual cycle	The roles of FSH, LH, oestrogen and progesterone in controlling the human menstrual cycle. The effect of oestrogen and progesterone on the uterine endometrium. The role of negative feedback in regulating hormone concentrations.
Contraception	The use of oral contraceptives based on oestrogen and progesterone in controlling fertility. **Candidates should be able to** evaluate the different methods of birth control.
Infertility	The treatment of female infertility with extracted and synthetic hormones and with drugs such as clomiphene which stimulate hormone activity. The key stages in *in vitro* fertilisation: • the use of fertility drugs to stimulate ovulation; • the collection of mature egg cells and their incubation with sperms; • the insertion of embryos into the uterus.

15.15 Pregnancy

Conception	Fertilisation, including capacitation, the role of the acrosome and formation of the fertilisation membrane.
Hormones and pregnancy	The roles of human chorionic gonadotrophin (HCG) and progesterone in controlling the events of pregnancy. Confirmation of pregnancy by determining HCG and progesterone levels.
The placenta	The structure of the placenta in relation to its role in the supply of substances to, and the removal of waste products from, the developing fetus.
Physiological changes in the mother	The changes in the following which take place during the course of a normal pregnancy and their physiological significance: • body mass; • plasma volume, red-blood-cell mass and cardiac output; • kidney function.

15.16 Human growth and development

Patterns of human growth	The pattern of growth of the whole body, reproductive organs and the brain from infancy to adulthood. **Candidates should be able to** represent graphically and interpret data relating to growth and growth rate.

Hormonal control	The roles of thyroxine, growth hormone and sex hormones in the control of human growth from infancy to maturity. Puberty and the principal physical changes associated with it. The evolutionary importance of a long pre-puberty stage in the human lifespan.
Ageing	The contributions to ageing of changes in physiological function, degeneration of tissue, accumulation of genetic error, and malfunction of the immune system.

15.17 Human populations and health

Population size and structure	Population growth rates, pyramids, survival rates and life expectancy. **Candidates should be able to:** • interpret population growth curves, survival curves and age pyramids; • calculate population growth rate from data on birth rate, death rate, emigration and immigration; • relate changes in the size and structure of human populations to different stages in demographic transition.
Social conditions	The influence of food supply, safe drinking water and effective sewage disposal on mortality.
Infectious disease	Pathogens, including certain bacteria, viruses and fungi, as the cause of infectious disease. Transmission of pathogens by droplet infection and contact, or in food and water. Natural immunity as production of antibodies in response to antigens. Immunological memory. (Details of the mechanisms of the immune response not required.) Artificial immunity by vaccination. The limitations of vaccination related to variability of antigens in pathogens. The herd immunity effect. **Candidates should be able to**: • interpret information relating to the incidence and mortality of diseases; • evaluate the effectiveness of immunisation programmes and changes in social conditions in preventing epidemics.
Effects of lifestyle on health	The constitution and importance of a balanced diet. The effects of excess fat and salt intakes, and of deficiency of mineral ions (calcium, iron and iodine) and vitamins (vitamins A, C and D). The relationships between diet, exercise and cardiovascular disease. Atheroma formation, formation of blood clots, aneurysm, myocardial infarction and cerebrovascular accident. The relationships between air pollution and smoking and chronic bronchitis, emphysema and lung cancer. The development and effects on lung function of bronchitis, emphysema and lung cancer. The relationship between ultra-violet light and malignant skin tumours. Tumour growth and metastasis.

	Candidates should be able to explain the biological effects of the disorders listed, and to evaluate measures that might be taken to reduce the risk factors.
Screening programmes	The principles involved in the use of x-rays, endoscopy, ultrasound and genetic techniques in diagnosis and screening programmes.
	Candidates should be able to: suggest the most appropriate technique to use in the diagnosis or screening of a particular condition; evaluate the issues arising from the use of screening programmes for inherited conditions.

Key Skills and Other Issues

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

16.1 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 National Qualification.

Copies of the Key Skills Units may be downloaded from the QCA web site (www.qca.org.uk/keyskills)

The units for each Key Skill comprise three parts:

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 B can be offered opportunities to develop and generate evidence of attainment in aspects of all of the Key Skills of *Application of Number*, *Communication, Information Technology, Improving Own Learning and Performance, Working with Others and Problem-solving*.. 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 Part 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.

16.2 Key Skills Opportunities in Biology B

The opportunites to understand theory, concepts and investigations in Biology B that necessitate candidates 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 the Key Skills and to produce evidence of their application.

The matrices below signpost the opportunities for Part B of the acquisition, development and production of evidence for the six 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
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
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
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
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
LP3.1 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
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 in the six tables above represents the opportunities to acquire and produce evidence of the Key Skills which are possible through this specification. There may be other opportunities to achieve these and other aspects of Key Skills via the specification, but such opportunities are dependent on the detailed course of study delivered within centres.

16.3 Key Skills in the Assessment of Biology B

The Key Skills of *Application of Number* and *Communication* must contribute to the assessment of Biology B. *Communication* is an intrinsic part of all four Assessment Objectives. Aspects of *Application of Number* are an intrinsic part of Assessment Objective AO3 and hence will form part of the assessment requirements for Units 3(b) and 5(b).

16.4 Further Guidance

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

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

17.1 Spiritual, Moral, Ethical, Social and Cultural Issues

The study of Biology lends itself to consideration of many spiritual, moral and cultural issues. The immense variety and complexity of living organisms ineluctably evoke awe and wonder, and candidates should be encouraged to appreciate and respect all forms of life. Consideration of the evidence for evolution and natural selection may lead candidates to reflect on ultimate questions relating to the origin and meaning of life. Many of the potential applications of biological understanding raise moral and ethical issues.

The following sections of the syllabus may be particularly apposite for analysis and discussion of spiritual, moral and cultural issues:

AS syllabus:

- use of genetically engineered microorganisms (11.4);
- gene therapy and the use of genetically modified animals (11.4);

A2 syllabus:

- balance between agricultural food production and conservation (15.6);
- evolution by natural selection and the origin of life (13.11);
- sustainability in agriculture and fishing (15.4);
- the human impact on natural ecosystems (14.5, 15.2);
- use of diagnostic genetic screening (15.17);
- use of immunisation programmes to protect a community (15.12);
- use and misuse of drugs such as antibiotics (15.12);
- the use of drugs that affect the nervous system and behaviour (13.6);
- methods of controlling human fertility and their impact (15.14).

17.2 European Dimension

AQA has taken account of the 1988 Resolution of the Council of the European Community in preparing this 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. Elements of health education occur throughout the specification but especially in the option, Microbes and Disease.

Other sections included are 11.4, 15.14 -15.17.

17.3 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 specification and associated specimen papers. The specification is designed to improve candidates' knowledge and understanding of environmental themes which occur in AS Module 1, A2 Module 5 and particularly the option, Applied Ecology, Module 6.

17.4 Avoidance of Bias

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

17.5 Terminology

The terminology used in all the written papers will be that described in the Institute of Biology Report *Biological Nomenclature* (third 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 Institute of Biology Report will be accepted, provided that the essential biological information is correctly supplied in the answer.

17.6 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 specifications. Detailed information may be found in pamphlets on safety issued by the Department for Education and Skills. 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.

17.7 Mathematical Requirements

In order to be able to develop the knowledge, understanding and skills in Sections 10 to15 above, candidates need to have been taught and to have acquired competence in the areas of mathematics set out below. Material relevant to the second part of 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 principles of sampling as applied to biological data;**
- **understand the importance of chance when interpreting data;**

- understand the terms mean, median and mode;
- use a scatter diagram to identify a correlation between two variables;
- **use a simple statistical test.**

NB Candidates should be familiar with the use of the chi-squared test, understand when it might be validly applied and be able to interpret results obtained. Candidates will not be expected to recall the formula in written papers. Other suitable statistical tests may be used in coursework.

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 Component

18 Nature of Centre-Assessed Component

18.1 Introduction

Coursework is used to assess the four skills in the experiment and investigation of the subject core for Biology as well as related synoptic elements in Skill E of Advanced Level. Coursework is allocated 15% of the total marks for the Advanced Subsidiary (AS) examination and 15% of the total marks for the Advanced (A Level) examination. The skills comprising the coursework component are as follows:

A. Planning

B. Implementing

C. Analysing evidence and drawing conclusions

D. Evaluating evidence and procedures

E. Synthesis of principles and concepts (A2 only)

The allocation of marks for each skill is in the ratio 8:8:8:6 for AS and 8:8:8:6:8 for A level.

18.2 Relationship of Coursework Skills to Assessment Objectives

Assessment Objectives	AS 50%	A2 50%	Total in A Level 100%
Experiment and Investigation (AO3)	7.5	5	12.5
Synoptic Assessment (AO4) (Skills A, C and E)	-	2.5	2.5

18.3 Subject Content

Investigations for AS must be based on the subject content for AS; Investigations for A2 must be based on the A Level subject content (AS and A2).

18.4 Early Notification

Centres must advise AQA of their intention to enter candidates using the form, *Estimated Entries* so that early contact can be made with new centres.

19 Guidance for Setting Centre-Assessed Component

19.1 Suitable Tasks

It is important that teachers consider carefully types of activity which will provide valid evidence for the purpose of assessment and which are ethical. The activities in which candidates are involved should be chosen to make reasonable demands and to enable positive achievements to be demonstrated in relation to the assessment criteria.

The criteria are different for AS and A Level as there are additional requirements for A2.

AS

For AS, candidates should be provided with a question or problem based on the content of AS modules which can be investigated. They are then expected to define the nature of the problem more precisely or to devise a testable hypothesis.

A2

It is essential that investigations used for assessment of A2 make appropriate demands on the candidates. It is important that candidates are provided with a stimulus which will assist them in formulating their ideas for investigations. They are then required to clarify and define the problem to be investigated, and to devise their own hypothesis to test. Investigations used for assessment in A2 must provide opportunities for a statistical test, such as student's t-test, chi-squared test or rank Spearman test, to be applied. The addition of a separate synoptic skill at A2 (Skill E - Synthesis of principles and concepts), requires opportunities to be provided for a synoptic approach to the skills of Planning and Analysing evidence and drawing conclusions. Candidates must be able to bring together principles, concepts and skills from different areas of biology.

Guidance on suitable activities is provided in the support material accompanying this specification and will be available at standardising meetings (see paragraph 22.1). Centres are encouraged to seek advice on whether their proposed activities are appropriate by contacting AQA or their Coursework Adviser.

19.2 Group Activities

It is recognised that working as part of a group on coursework activities provides valuable learning experiences and often permits the collection of more reliable and valid data. However, judgements based on the evidence of what candidates do in an investigation as part of a group can be difficult to obtain accurately. The following arrangements should be adopted when making final assessments for submission to AQA.

The assessment of Skill A - Planning should be done under supervision to give candidates opportunities to use their own knowledge and make use of secondary sources. Planning should not be a collaborative exercise. The completed plans should be collected from the candidates before they embark on implementation and checked to ensure that the plan meets safety, health and ethical guidelines. It should be assessed at this stage. The plan cannot be

changed but modifications can be incorporated at the implementation stage and commented upon when evaluating evidence and procedures for Skill D assessment.

It may be appropriate for the plan to be implemented as part of a group activity. However, assessments can be made only where the individual contribution of a candidate can be identified. If this is not possible, no marks can be awarded.

The processing of marks may involve writing a report, analysing and evaluating, using IT as appropriate. It may be necessary for such work to be carried out outside immediate supervision but in making assessments, teachers must be satisfied of the authenticity of the individual candidate's own work. Where group results are used, candidates should indicate clearly which data they have obtained themselves.

19.3 Teaching Strategies

It is intended that learning opportunities for developing experimental and investigative skills are provided during normal coursework and form an integral part of the scheme of work. It is important therefore that the teaching programme should include activities designed to develop these skills and that assessments should arise naturally from coursework activities which build on the subject content of the specification.

Teachers are encouraged to explain to students the criteria on which each of the assessments will be made. Candidates should understand how to present good scientific reports of their investigation, and may be helped by seeing examples showing good practice and standard conventions. When assessments are being made, some assistance may be given by the teacher, but it is important that such information should be general and not specifically related to the particular investigation.

The coursework assessment carries a weighting of 15% in each of the AS and the A2 specifications and centres should apportion a commensurate amount of time for learning opportunities and assessment of these units.

20 Assessment Criteria

20.1 Assessment of the four skills in relation to the type of activity used.

AS

For the AS assessment all four skills could be assessed on the same investigation or separate skill assessments could be taken from a number of different investigations. This allows for the assessment of Planning (Skill A) in an independent activity where it is not practicable actually to implement the plan. However, Evaluating evidence and procedures (Skill D) must always be assessed together with Implementing (Skill B) and Analysing evidence and drawing conclusions (Skill C). The best mark for each of these skills may be taken from different investigations, but evidence of the whole activity must still be sent to the moderator.

A2

For the A2 assessment all five skills must be carried out on the **same** investigation. Care must be taken to ensure that a candidate's performance on one skill does not adversely affect the scope to demonstrate attainment in another. For example, having been assessed on planning an investigation, a candidate may be given help to modify a plan before proceeding to the implementation of the investigation. Similarly, if a candidate fails to obtain satisfactory results from an investigation, additional data may be provided for analysing evidence and drawing conclusions. The nature of such guidance should be clearly shown on the candidate's work. No help should be given **during** assessment of a particular skill, unless it is to prevent unsafe, unethical or environmentally unacceptable practices, and guidance should only be given in order that assessment of other skills is not adversely affected. Guidance must be limited to the minimum required to demonstrate the other skills.

20.2 The number of assessments required

Assessments must be submitted on **one** occasion for the AS examination and on **one** occasion for the A2 examination. The coursework for AS Level must be carried out in the context of the AS subject content (Modules 1-3(a)).
The coursework for A2 may be based on any part of the A level subject content (Modules 1-6/7/8) but must be different in its content from that used for the AS assessment.

20.3 The marking of coursework and standardisation

Marks should be awarded for the four experimental skills listed below and for the synoptic skill at Advanced level. Standards are set by the use of mark criteria which describe the performance expected for a particular mark in each skill area. The marks submitted to AQA should be awarded using only the mark criteria printed below.

The skills to be assessed are:

A. Planning

B. Implementing

C. Analysing evidence and drawing conclusions

D. Evaluating evidence and procedures

E. Synthesis of principle and concepts (A2 only)

Descriptions are provided for 2, 4, 6 and 8 marks in skill areas A, B, C and E and 2, 4 and 6 marks in skill area D. The performance needed to gain 6 marks in skill area D is commensurate with that for 8 marks in the other skill areas. Whenever assessments are made, the mark descriptors should be used to judge which mark best fits the candidate's performance. The statements should not be taken as discrete and literal hurdles, all of which must be fulfilled for a mark to be awarded.

The mark descriptions within a skill area are designed to be hierarchical. This means that, in general, a description at a particular mark subsumes those at lower marks. Adjacent descriptions should be considered when making judgements and use made of the intermediate marks (i.e. 3, 5 and 7) when performance exceeds one description and only partially satisfies the next. A candidate who fails to meet the requirements for 2 marks, but who has made a creditworthy attempt in a skill area should be given 1 mark for that skill. Zero marks should only be awarded for a skill area in the event of a candidate failing to demonstrate any achievement in that skill.

20.4 Criteria for assessment of practical skills for AS Level

A. PLANNING

The candidate is expected to:

(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.

In this skill it is important that candidates are provided with a question or problem which might be investigated, but not a precise set of instructions. This will enable them to define the nature of the problem more precisely or to devise a testable hypothesis thus giving them an opportunity to meet all the criteria. After planning an investigation, it may be necessary for the plan to be modified before it can be carried out. Where this is done with help from the teacher, an indication must be given at the appropriate point in the evidence of any guidance given. Evidence for this skill should be submitted as the original design written in the future tense, rather than as an account written up after completion of the task.

It is essential that all investigations are safe, and ethically and environmentally acceptable. Where a plan is considered to be unsafe, or ethically/environmentally unacceptable, a candidate should not be permitted to implement the plan.

Mark Criteria

The candidate can

2 define the problem being investigated, suggest the relevant procedures to be used and select appropriate equipment and materials to carry out the task.

4 design a plan in which enough relevant factors are taken into account and controlled in order to obtain valid data.

6 describe the observations, measurements and precautions needed to obtain valid and, where appropriate, quantitative data.

8 provide a reasoned explanation for the procedures selected, describe the anticipated method for collecting the data, and suggest how they might be analysed.

B. IMPLEMENTING

The candidate is expected to:

(a) use apparatus and materials in an appropriate and safe way;

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

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

For assessment of this skill, instructions for carrying out an experiment can be the candidate's original plan or a modified version of it. Alternatively an outline plan may be provided, which may be totally different from the candidate's own plan. In all cases, however, instructions used by candidates should give them the opportunity to make decisions (e.g. concerning the number of measurements to be made or the appropriate equipment to use to make quantitative measurements). They should not be totally prescriptive, otherwise it will limit the marks which can be obtained.

The amount of data obtained will depend on the nature of the investigation and the time available, but should reflect what is possible during a normal practical session.

It is essential that safety and the well-being of living organisms and the environment form an integral part of the investigation.

Mark Criteria

The candidate can

2 safely use appropriate techniques and equipment to obtain and record some relevant observations and measurements, with units given where applicable.

4 use techniques and equipment in a methodical and organised way to obtain and record an adequate range of valid observations and measurements.

6 use appropriate techniques and equipment to make detailed observations and suitably accurate quantitative measurements, and record these in a clear and understandable form.

8 take precautions to ensure the reliability of the data obtained in relation to the problem being investigated.

C. ANALYSING EVIDENCE AND DRAWING CONCLUSIONS

The candidate is expected to:

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

(b) recognise and comment on trends and patterns in the data;

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

Mark Criteria

The candidate can

2 carry out some processing of results, e.g. in the form of a simple graph, chart or diagram, and identify the main pattern or trend.

4 process the data obtained with appropriate graphs and calculations, describe the relevant trends and patterns and provide a conclusion or solution to the problem which is consistent with the data.

6 using appropriate scientific terminology, provide a full report of the data obtained, analyse in detail patterns within the data obtained and draw appropriate conclusions.

8 make a full analysis of the outcomes of the investigation, supporting these with appropriate evidence from the data and explaining conclusions in relation to scientific knowledge.

D. EVALUATING EVIDENCE AND PROCEDURES

The candidate is expected to:

(a) assess the reliability and precision of experimental data and the conclusions drawn from them;

(b) evaluate the techniques used in the experimental activity, recognising their limitations.

In this skill it is important that errors, anomalies and limitations relate to the apparatus available, the techniques used and data obtained when good implementation skills are used. Comments relating to avoidable errors resulting from careless techniques, inappropriate equipment or collection of insufficient data (when this was possible in the time available) should not be awarded marks in the assessment of this skill.

Mark Criteria

The candidate can

2 recognise the limitations of the apparatus and techniques used.

4 assess the effect of the limitations of the apparatus and techniques on the reliability and precision of the data obtained.

6 assess the effect of the limitations of the apparatus, techniques and reliability on the conclusions made.

20.5 Criteria for assessment of practical skills at A Level

Assessment of all five skills must be carried out on the **same** investigation at A Level. The criteria for AS and A Level are different as there are additional requirements for A2. In particular it is essential that investigations used for assessment of A2 make appropriate demands on the candidate, and require the candidate to synthesise biological principles and concepts when considering factors to be taken into account in the plan and when analysing and explaining the outcomes of the investigation.

A. PLANNING

The candidate is expected to:

(a) identify and define the nature of a question or problem using scientific 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 suitable for statistical tests;

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

In this skill it is important that candidates are provided with a stimulus and ideas to begin investigations, rather than being expected to generate original ideas for themselves. This will give them the opportunity to clarify and define the problem to be investigated, and enable them to devise their own hypothesis to test. It is essential that planned investigations provide opportunities for statistical testing and require candidates to draw on fundamental principles in Biology.

After planning an investigation, it may be necessary for it to be modified before it can be carried out. Where this is done with help from the teacher, an indication must be given at the appropriate point in the evidence of any guidance given which has significant assessment implications.

Evidence for this skill should be submitted as the original design written in the future tense, rather than an account written up after completion of the task. In order to be able to assess Skill E, the plan must include the background knowledge, principles and concepts on which the investigation is to be based.

It is essential that all investigations are safe, and ethically and environmentally acceptable. Where a plan is considered to be unsafe, or ethically/environmentally unacceptable, a candidate should not be permitted to implement the plan.

Mark Criteria

The candidate can

2 suggest relevant procedures to be used and select appropriate equipment to carry out the task.

4 design a plan in which enough relevant factors are taken into account and controlled in order to obtain valid data.

6 describe the observations, measurements and precautions needed to obtain valid quantitative data.

8 provide a reasoned explanation for the procedures selected, describe the anticipated method of collecting the data and suggest how they might be analysed, including an appropriate simple statistical test to support or reject the hypothesis being tested.

Appropriate simple statistical techniques include:

student's t-test;

chi-squared test;

rank Spearman test.

B. IMPLEMENTING

The candidate is expected to:

(a) use apparatus and materials in an appropriate and safe way;

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

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

For assessment of this skill, instructions for carrying out an investigation can be the candidate's original plan or a modified version of it. Where help is given, it should not be too prescriptive, otherwise it will limit the marks which can be awarded. Candidates should have the opportunity to make decisions (e.g. concerning the number of measurements to be made or the appropriate equipment to use to make quantitative measurements). Any help given should be noted on the candidate's report.

The amount of data obtained (range and number of readings) will depend on the nature of the investigation, but should reflect what is required in order to carry out a statistical test.

It is essential that safety and the well-being of living organisms and the environment form an integral part of the investigation.

Mark Criteria

The candidate can

2 safely use appropriate techniques and equipment to obtain some relevant observations and measurements, with units given where applicable.

4 use techniques and equipment in a methodical and organised way to obtain and record an adequate range of valid observations and measurements.

6 use appropriate techniques and equipment to make detailed observations and suitably accurate quantitative measurements, and record these in a clear and understandable form.

8 take precautions to ensure the reliability of the data obtained in relation to the problem being investigated.

C. ANALYSING EVIDENCE AND DRAWING CONCLUSIONS

The candidate is expected to:

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

(b) recognise and comment on trends and patterns in the data;

(c) draw valid conclusions by applying biological knowledge and understanding;

(d) apply a simple statistical test and, where appropriate, assign confidence limits to experimental results.

Mark Criteria

The candidate can

2 carry out some processing of results, e.g. in the form of a simple graph, chart or diagram, and identify the main pattern or trend.

4 process the data obtained with appropriate graphs and calculations, describe the relevant trends and patterns and provide a conclusion or solution to the problem which is consistent with the data.

6 use appropriate scientific terminology to provide a full report of the data obtained, analyse in detail patterns within the data obtained and draw appropriate conclusions.

8 make a full analysis of the outcomes of the investigation, supporting these with appropriate evidence from the data and explaining conclusions in relation to scientific knowledge.

D. EVALUATING EVIDENCE AND PROCEDURES

The candidate is expected to:

(a) assess the reliability and precision of experimental data and the conclusions drawn from them;

(b) evaluate the techniques used in the experimental activity, recognising their limitations.

In this skill it is important that errors, anomalies and limitations relate to the apparatus available, the techniques used and data obtained when good implementation skills are used. Comments relating to avoidable errors resulting from careless techniques, inappropriate equipment or collection of insufficient data should not be awarded marks in the assessment of this skill.

Mark Criteria

The candidate can

2 recognise the limitations of the apparatus and techniques used.

4 assess the effect of the limitations of the apparatus and techniques on the reliability and precision of the data obtained.

6 assess the effect of the limitations of the apparatus, techniques and reliability on the conclusions made.

E. SYNTHESIS OF PRINCIPLES AND CONCEPTS

The candidate is expected to:

bring together principles and concepts from different areas of biology and apply them to the investigation, expressing ideas clearly and logically and using appropriate specialist vocabulary.

Assessment of this skill will be based on the reports of both the planning of the investigation and the analysis of the outcomes (Skills A and C). In the planning candidates should use their biological knowledge and understanding of principles and concepts to identify, describe, explain and justify the range of factors to be taken into account. In the analysis candidates should use their overall knowledge and understanding of biological principles and concepts to explain the outcomes of the investigation.

Mark Criteria

The candidate can

2	select some appropriate knowledge and principles.
4	select some knowledge and principles and explain their relevance to the investigation.
6	select most of the relevant knowledge and principles, provide a reasonable explanation of their significance to the investigation and generally present the account clearly and logically using appropriate scientific terminology.
8	select knowledge, principles and concepts, all of which are relevant to the investigation, explain their significance and apply them to the specific situation; present the account clearly and logically using appropriate scientific terminology effectively and accurately throughout.

20.6 Evidence to Support the Award of Marks

The investigations must be annotated to identify where in the work the relevant criteria have been met. Teachers may find it useful to use the mark descriptor letterings for the purpose, e.g. A4 or C6, together with written comments on why particular marks have been awarded.

21 Supervision and Authentication

21.1 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.
21.2 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*.
21.3 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.
21.4 Authentication of Candidates' Work	Both the candidate and the teacher are required to sign declarations on the *Candidate Record Form*, 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 is required to record details of any additional assistance.

22 Standardisation

22.1 Standardisation Meetings

Annual standardisation 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.

22.2 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 a signed form *(Centre Declaration Sheet)* confirming 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.

22.3 Centre Consortium Arrangements

Where candidates from different centres have been taught together, and standardisation of marking has been carried out, candidates should be treated as a single group for the purposes of moderation. In this case the Processing – Examining Department at AQA must be informed in advance of the moderation period.

23 Administrative Procedures

23.1 Recording Assessments

The candidates' work must be marked according to the assessment criteria set out in Section 20. Teachers should keep records of their assessments during the course in a form which facilitates the complete and accurate submission of the final overall assessments at the end of the course.

23.2 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.

23.3 Factors Affecting 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. Details are available from AQA and centres should ask for a copy of *Regulations and Guidance relating to Candidates with Particular Requirements.*

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.

23.4 Retaining Evidence and Re–Using Marks

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

Candidates re-taking a unit containing coursework may carry forward their moderated coursework marks. These marks have a shelf-life which is limited only by the shelf-life of the specification, and they

may be carried forward an unlimited number of times within this shelf-life.

Candidates re-taking Unit 3 may wish to submit new coursework. In this case the requirements outlined in Section 20.1 must be fulfilled and, in addition, the new marks must be obtained from different investigations from those used for the original assessment. If the work of such a candidate is requested by the moderator, all of the work supporting the new total mark must be sent. Centres should be aware that the mark submitted for all skills (both old and new work) will be moderated.

24 Moderation

24.1 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 by 10 January (January series) or 15 May (June series) in the year in which the qualification is awarded.

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.

24.2 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 with a report form from the moderator 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

25 Grading, Shelf-Life and Re-Sits

25.1 Qualification Titles

The qualifications based on these specifications have the following titles:

AQA Advanced Subsidiary GCE in Biology (B)
AQA Advanced GCE in Biology (B).

25.2 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.

25.3 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.

25.4 Assessment Unit Re-Sits

Each assessment unit may be re-taken an unlimited number of times within the shelf-life of the specification. The best result will count towards the final award. Candidates who wish to repeat an award must enter for at least one of the contributing units and also enter for certification (cash-in). There is no facility to decline an award once it has been issued.

25.5 Carrying forward of Coursework Marks

Candidates re-taking a unit containing coursework may carry forward their moderated coursework marks. These marks have a shelf-life which is limited only by the shelf-life of the specification, and they may be carried forward an unlimited number of times within this shelf-life.

25.6 Minimum Requirements

Candidates will be graded on the basis of work submitted for assessment. Zero marks rather than absent will be recorded where no component has been submitted.

25.7 Awarding and Reporting

This specification complies with the grading, awarding and certification requirements of the current *GCSE, GCE, VCE, GNVQ and AEA Code of Practice 2006/7* and will be revised in the light of any subsequent changes for future years.

Appendices

A Grade Descriptions

The following grade descriptors 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.

The Candidate Record Forms have been deleted from this specification because of changed requirements. The latest version of the forms are on the Coursework Administration pages of the Website.

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C

Overlaps with other Qualifications

GCE Qualifications

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.

Chemistry

There are minimal overlaps with chemistry though some areas of biochemistry are covered in both specifications such as the structure of organic molecules, bonding and the action of enzymes.

Environmental Science

There are overlaps in the areas of life processes, ecology, populations, agricultural production and fish farming.

Physics

There is a marginal overlap with medical physics.

Science

The following topics receive some coverage in both specifications:

cell structure, photosynthesis and respiration, ecosystems, nutrient cycles, evolution and biochemistry, biological molecules, reproduction and inheritance, adaptation to the environment, genes and genetic engineering.

Science for Public Understanding (AS)

There are overlaps in the areas of cells, disease, genetics, evolution, ecosystems and health.

AVCE Qualifications

Science

There are some overlaps with the following units.

Compulsory units

- Unit 1: Investigating science at work.
- Unit 2: Monitoring the activity of the human body
- Unit 6: Carrying out scientific investigations

AQA Optional units

- Unit 7: Obtaining products from organisms
- Unit 8: Food science and technology
- Unit 9: Role of the pathology service in health care
- Unit 10: The biochemistry of health care
- Unit 11: Actions and development of medicines
- Unit 14: Energy resources and the environment
- Unit 15: Sports science

Health and Social Care

There are some overlaps with the following units.

Unit 3: Physical aspects of health

Unit 4: Factors affecting human growth and development

Unit 13: The role of exercise in maintaining health and well-being

Unit 19: Environmental health

Unit 21: Medical physics for health and social care