Oxford Cambridge and RSA Examinations

OCR AS GCE in Biology (3881)

OCR Advanced GCE in Biology (7881)

Approved Specifications – Revised Edition

First Advanced Subsidiary GCE certificate was 2001 QAN (3881) 100/0593/6
First Advanced GCE certification was 2002 QAN (7881) 100/0461/0

Foreword to Revised Edition

This Revised Edition has been produced to consolidate earlier revisions to these specifications and any changes contained within have previously been detailed in notices to centres. **There is no change to the structure or teaching content of the specification and most differences are cosmetic**. Sidelining will be used to indicate any significant changes.

Re-sits of Units - The restrictions on re-sitting units have been removed, enabling candidates to re-take units more than once (for details see page 22).

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Foreword (continued)

This booklet contains OCR's Advanced Subsidiary GCE (AS) and Advanced GCE (A level) Biology specifications for teaching from September 2004.

The AS GCE is assessed at a standard appropriate for candidates who have completed the first year of study of a two year Advanced GCE course, i.e. between GCSE and Advanced GCE. It forms the first half of the Advanced GCE course in terms of teaching time and content. When combined with the second half of the Advanced GCE course, known as 'A2', the AS forms 50% of the assessment of the total Advanced GCE. However, the AS can be taken as a 'stand-alone' qualification. A2 is weighted at 50% of the total assessment of the Advanced GCE.

In these specifications the term **module** is used to describe specific teaching and learning requirements. The term **unit** describes a unit of assessment.

Each teaching and learning module is assessed by its associated unit of assessment.

These specifications are part of a suite of linked specifications in the sciences. All have similar structures and schemes of assessment. The suite comprises:

Biology	**3881 & 7881**
Chemistry	**3882 & 7882**
Physics A	**3883 & 7883**
Geology	**3884 & 7884**
Science	**3885 & 7885**

These specifications meet the requirements of the Common Criteria (Qualifications and Curriculum Authority, 1999), the GCE AS and Advanced Level Qualification-Specific Criteria (QCA, 1999) and the relevant Subject Criteria (QCA, 1999).

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Specification Summary

Outline

The OCR AS GCE and Advanced GCE Biology specifications cover all the content identified in the Biology Subject Criteria (QCA 1999) in compulsory units whilst A2 optional units give candidates the opportunity to explore an area of biology in depth. Some options deal with modern applications of biology, whilst others cover more traditional areas.

The assessment of Experimental Skills is flexible with coursework and practical examination alternatives in both AS and A2.

Specification Content

Modules 2801, 2803 and 2804 cover the content identified in the QCA Subject Criteria for Biology (QCA 1999). Module 2802, Human Health and Disease, complements the AS content of the Biology Subject Criteria and provides further study of important health education topics. Module 2805 provides **five options** of which **one** is chosen for study. The options are as follows:

- Component 01 Growth, Development and Reproduction;
- Component 02 Applications of Genetics;
- Component 03 Environmental Biology;
- Component 04 Microbiology and Biotechnology;
- Component 05 Mammalian Physiology and Behaviour.

Scheme of Assessment

The AS GCE forms 50% of the assessment weighting of the full Advanced GCE. AS GCE is assessed at a standard between GCSE and Advanced GCE and can be taken as a stand-alone specification, or as the first part of the full Advanced GCE course.

Assessment is by means of **three Units of Assessment** for AS GCE and **six Units of Assessment** for Advanced GCE:

AS GCE Candidates take Units 2801, 2802 and 2803.

In Unit 2803, candidates take **either** Components 01 and 02 or Components 01 and 03.

Advanced GCE Candidates take Units 2801, 2802, 2803, 2804, 2805 and 2806.

In Unit 2803, candidates take **either** Components 01 and 02 or Components 01 and 03.

In Unit 2805, candidates take **one** of Components 01 – 05.

In Unit 2806, candidates take **either** Components 01 and 02 **or** Components 01 and 03.

Units of Assessment

Level	Unit/ Component	Name	Duration	Mode of Assessment	Weighting	
					AS	Advanced GCE
AS	2801	Biology Foundation	1 hour	Written Examination	30%	15%
	2802	Human Health and Disease	1 hour	Written Examination	30%	15%
	2803	Transport/ Experimental Skills 1				
	/01	Transport	45 mins	Written Examination	20%	10%
	/02	Coursework 1	-	Coursework	20%	10%
	/03	Practical Examination 1	1 hour 30 mins	Practical Examination	20%	10%
A2	2804	Central Concepts	1 hour 30 mins	Written Examination	-	15%
	2805	Options in Biology (one of)				
	/01	Growth, Development and Reproduction	1 hour 30 mins	Written Examination	-	15%
	/02	Applications of Genetics	1 hour 30 mins	Written Examination	-	15%
	/03	Environmental Biology	1 hour 30 mins	Written Examination	-	15%
	/04	Microbiology and Biotechnology	1 hour 30 mins	Written Examination	-	15%
	/05	Mammalian Physiology and Behaviour	1 hour 30 mins	Written Examination	-	15%

Units of Assessment (continued)

Level	Unit/ Component	Name	Duration	Mode of Assessment	Weighting	
					AS	Advanced GCE
A2	2806	Unifying Concepts in Biology/ Experimental Skills 2				
	/01	Unifying Concepts in Biology	1 hour 15 mins	Written Examination	-	10%
	/02	Coursework 2	-	Coursework	-	10%
	/03	Practical Examination 2	1 hour 30 mins	Practical Examination	-	10%

In Unit 2803, candidates take **either** Components 01 and 02 or Components 01 and 03.

In Unit 2805, candidates take **one** of Components 01 – 05.

In Unit 2806, candidates take **either** Components 01 and 02 or Components 01 and 03.

Question Paper Requirements

The question papers for Units 2801, 2802, 2803 (Component 01), 2804, 2805 and 2806 (Component 01) have a common format. They contain both structured questions and questions which require more extended answers. All questions on these papers are compulsory. Quality of written communication is assessed within those parts of the questions which require more extended answers.

The question paper for Units 2805 (Components 01-05) contains questions covering synoptic assessment.

Unit 2806 (Component 01) is a synoptic paper which requires candidates to draw together knowledge gained in the study of Modules 2801, 2802 and 2803 of the AS GCE specification and Module 2804 of the Advanced GCE specification.

All questions on the practical examination papers, Unit 2803 (Component 03) and Unit 2806 (Component 03), are compulsory. The practical examination papers Unit 2803 (Component 03) and Unit 2806 (Component 03) are alternatives to coursework (Unit 2803 (Component 02) and Unit 2806 (Component 02) respectively).

Experimental and Investigative Skills

Experimental skills for AS GCE and Advanced GCE are assessed by:

- **either** coursework components (Unit 2803 (Component 02) and Unit 2806 (Component 02));
- **or** by external practical examination components (Unit 2803 (Component 03) and Unit 2806 (Component 03)).

Candidates may combine two methods of assessment by taking the coursework route in AS, i.e. Unit 2803 (Component 02) with the practical examination route in A2 Unit 2806 (Component 03) or vice versa.

Coursework

For both AS GCE and Advanced GCE, candidates can be internally assessed on four experimental and investigative skills. One mark per skill must be awarded for each candidate, for AS GCE (Unit 2803, Component 02) and for A2 (Unit 2806, Component 02). Work is marked by the teacher, internally standardised in the Centre, and externally moderated by OCR. There is an element of synoptic assessment in Unit 2806 (Component 02).

External Examination

For both AS GCE and Advanced GCE, candidates can take an externally set and marked practical examination. There is an element of synoptic assessment in Unit 2806 (Component 03).

Overlap with other qualifications

There are overlaps between this specification in Biology and the OCR specifications for Chemistry, Physics A, Science, Geography A, Geography B, Geology and Advanced GNVQ Science. The links between the specifications may allow for some co-teaching, especially in the areas of biochemistry, environmental science and microbiology (See section 1.3).

1 Introduction

These OCR Biology specifications lead to qualifications at AS GCE and Advanced GCE in **Biology**. Candidates take three Units of Assessment for AS and a further three units for A2 if they are seeking an Advanced GCE award. AS and A2 combined constitute the full Advanced GCE specification. There are coursework alternatives in both AS and A2.

These specifications have been developed for candidates who wish to continue with a study of Biology after GCSE. Some candidates may wish to follow a Biology course for only one year as an AS GCE, in order to broaden their curriculum. Others will continue for a further year extending their course to Advanced GCE. Such a course prepares candidates to progress into further or higher education, to follow courses in Biology, one of the other sciences or related subjects, or to enter employment where a knowledge of Biology would be useful. Study of AS GCE or Advanced GCE Biology should also be seen as making a contribution towards life-long learning.

Experience of the role of experimental work is important in any course in Biology and is recognised in these specifications by the inclusion of coursework, or practical examinations components, in both AS and A2, based on assessment of experimental skills.

The assessment of experimental and investigative skills builds from GCSE. The skills cover the same areas as Sc1 of GCSE, and the mark descriptors are formulated in the same way as the GCSE mark descriptors.

The AS GCE specification builds from grade CC in GCSE Science: Double Award, or equivalent in Science: Biology. For this reason, recommended prior knowledge within the AS units in Section 5 is described in terms of National Curriculum statements. However, candidates from other educational backgrounds with equivalent experience will have the necessary prior knowledge.

It is expected that social, economic, environmental, ethical, medical and technological aspects of biology will be incorporated into the delivery of these specifications. References to these aspects of biology are integrated into the units throughout the course.

1.1 Certification Title

These qualifications are shown on a certificate as

- OCR Advanced Subsidiary GCE in Biology.
- OCR Advanced GCE in Biology.

1.2 Language

These specifications and associated assessment materials are available in English only.

1.3 Overlap with Other Qualifications

There are overlaps between these specifications in Biology and the OCR specifications for Chemistry, Physics A, Science, Geography A, Geography B, Geology and Advanced GNVQ Science. The links between the specifications may allow for some co-teaching, especially in the areas of biochemistry, environmental science and microbiology. Listed below are some specific examples of the links between Biology and the other specifications. The list is not intended to be exhaustive. Teachers will find other such links allowing them to support and enhance the learning of their candidates.

Overlap with Chemistry (3882, 7882)

- Foundation Chemistry (Module 2811) supports the study of section 5.1.2, Biological Molecules, in Biology Foundation (Module 2801). Chemical bonding and the properties of water are included in the Chemistry unit.
- There are strong links between Biology Foundation (Module 2801) and the Optional Unit on Biochemistry (Module 2815, Component 02) in the Chemistry specification. All the topics included in the Chemistry component are included in the Biology AS specification.
- The following topics are included in Environmental Biology (Module 2805, Component 03) and Environmental Chemistry (Module 2815, Component 03): atmospheric composition and change; the greenhouse effect and global warming; water quality and water treatment; conservation of natural resources; waste treatment.

Overlap with Physics A (3883, 7883)

- A study of section 5.9.3, Support and Locomotion, in the Optional Unit Mammalian Physiology and Behaviour (Module 2805, Component 05) supports the section Body Mechanics in the Optional Unit Health Physics (Module 2825, Component 02) in the Physics A specification.
- There are strong links between section 5.9.5, Sense Organs and the Reception of Stimuli, in the Optional Unit Mammalian Physiology and Behaviour (Module 2805, Component 05) and the section The Eye and Sight, The Ear and Hearing in the Optional unit Health Physics (Module 2825, Component 05).

Overlap with Science (3885, 7885)

- There are strong links between the AS and A2 Biology specifications and those for Science, particularly with reference to topics such as biological molecules, energy transfer, ecosystems, genetics and inheritance, evolution and various environmental concerns.

Overlap with Geography A (3832, 7832)

- A study of section 5.1.7, Energy and Ecosystems, in Biology Foundation (Module 2801) supports the study of Ecosystems (in Module 2680) in the Geography A specification.
- Succession is studied in some detail in Module 2680 of the Geography A specification. The principles, examples and any case studies included in the Geography AS course will support section 5.4.3, Population and Interactions, in Module 2804 (Central Concepts) in the Biology specification.
- Aspects of human nutrition and health studied in Module 2802 (Human Health and Disease) of the Biology specification will support the section Food Supplies in the optional module Agriculture and Food in the Geography A specification.

There are strong links to be made between fieldwork techniques and methods of data analysis and presentation especially for those candidates taking Environmental Biology (Module 2805, Component 03).

Overlap with Geography B (3834, 7834)

- The study of ecology and aspects of human health and disease in the AS Biology specification support Module 2691 (Issues in the Environment) and Module 2692 (Issues in Sustainable Development) in Geography B.
- There are strong links to be made between fieldwork techniques and methods of data analysis and presentation, especially for those candidates taking Environmental Biology (Module 2805, Component 03).

Overlap with Geology (3884, 7884)

- The section Evolution and Extinction in Module 2834 in the Geology specification is supported by section 5.4.5, Classification, Selection and Evolution, in Central Concepts (Module 2804) in the Biology specification.

Overlap with Advanced GNVQ Science

- Laboratory techniques, methods of data analysis and presentation, and approaches to scientific enquiry are common to Biology and Advanced GNVQ Science.
- A study of Transport (Module 2803, Component 01) and Human Health and Disease (Module 2802) support the compulsory GNVQ Unit Monitoring the Activity of the Human Body (Unit 7441).
- A study of Biology Foundation (Module 2801) and Microbiology and Biotechnology (Module 2805, Component 04) support the compulsory GNVQ Unit Synthesising Organic and Biochemical Compounds (Unit 7444).
- A study of Human Health and Disease (Module 2802) supports the Optional GNVQ Units Using Psychology (Unit 7458), Maintaining Environmental Health (Unit 7454) and Using Nutrition to Maintain Health (Unit 7461).
- There are strong links between Environmental Biology (Module 2805, Component 03) and the Optional GNVQ Unit Ecology and Managing the Environment (Unit 7451).
- There are links between Microbiology and Biotechnology (Unit 2805, Component 04) in the Biology A2 specification and the Optional GNVQ Unit Maintaining Environmental Health (Unit 7459).

1.4 Exclusions

Candidates who enter for this AS GCE specification may **not** also enter for any other AS GCE specification with the certification title Biology in the same examination session.

Candidates who enter for this Advanced GCE specification may **not** also enter for any other Advanced GCE specification with the certification title Biology or Science in the same examination session.

Every specification is assigned 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 these specifications is 1010.

1.5 Code of Practice requirements

These specifications will comply in all respects with the 2004 revised Code of Practice.

2 Specification Aims

The aims of these AS GCE and Advanced GCE specifications are to encourage candidates to:

- develop essential knowledge and understanding of the 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.

In addition, the Advanced GCE specification aims to encourage candidates to:

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

2.1 Spiritual, Moral, Ethical, Social and Cultural Issues

These specifications provide an opportunity for candidates to appreciate:

- a sense of awe and wonder at the scale and impact of natural processes and phenomena;
- the role of biology in describing the structure and functioning of the natural world;
- the importance of animals, plants and microorganisms to life on earth;
- the place of mankind in the natural world;
- the moral, ethical, social and cultural implications of some of the applications of biology and technology.

2.2 Environmental Education

Aspects of environmental education feature throughout these specifications, but the following are explicitly covered in the compulsory units:

- importance of the Sun in sustaining life on Earth;
- energy and mineral cycling;
- interdependence of living things;
- biodiversity;
- ecosystem management and sustainable agricultural practices.

Further aspects of environmental education are covered in Environmental Biology (Module 2805, Component 03), such as:

- greenhouse effect and global warming;
- air, water and pesticide pollution;
- conservation of resources;
- environmental monitoring.

The following aspect of environmental education is covered in Microbiology and Biotechnology (Module 2805, Component 04):

- clean technology and industrial processes.

2.3 European Dimension

Although these specifications do not make specific reference to scientific aspects of the European Dimension, it may be drawn into the course of study in many ways. For example, there are references to the Human Genome Project, as well as references to environmental biology which should use examples drawn from European contexts, wherever possible.

2.4 Health Education

Aspects of health education feature throughout these specifications, but the following are explicitly covered in the compulsory units:

- diet and malnutrition;
- causes and prevention of coronary heart disease;
- effects of exercise on the body;
- smoking and related diseases;
- infectious diseases and their treatment;
- immunity and vaccination;
- diabetes and its treatment.

The following aspects of health education are covered in Growth, Development and Reproduction (Module 2805, Component 01):

- contraception, IVF and abortion;
- maternal health and fetal development;
- hormone replacement therapy.

The following aspects of health education are covered in Applications of Genetics (Module 2805, Component 02):

- genetic disorders;
- genetic screening and counselling.

The following aspects of health education are covered in Mammalian Physiology and Behaviour (Module 2805, Component 05):

- effects of alcohol on the body;
- effects of ageing on the locomotory system;
- Alzheimer's disease;
- cataracts

2.5 Economic and Industrial Understanding

These specifications promote understanding of the following:

- genetic engineering;
- biotechnology;
- agricultural industry;
- timber production;
- manufacturing industry;
- water purification.

2.6 Avoidance of Bias

OCR has taken great care in the preparation of these specifications and assessment materials to avoid bias of any kind.

3 Assessment Objectives

Knowledge, understanding and skills are closely linked. These specifications require that candidates demonstrate the following assessment objectives in the context of the content and skills prescribed. Assessment Objectives AO1-AO3 are the same for AS GCE and Advanced GCE; AO4 applies only to the A2 part of the Advanced GCE course.

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 appropriate vocabulary where appropriate.

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.

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.

AO4 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.

The Assessment Objectives are weighted as follows:

	AS GCE	A2	Advanced GCE
AO1	48%	25%	36.5%
AO2	32%	25%	28.5%
AO3	20%	10%	15%
AO4	0%	40%	20%

3.1 Specification Grid

The relationship between the Assessment Objectives and the Units of Assessment in the Advanced GCE specification is shown in the specification grid below.

Unit of Assessment		Level	Percentage of Advanced GCE				Total
			AO1	AO2	AO3	AO4	
2801		AS	9	6	0	0	15
2802		AS	9	6	0	0	15
2803	Component 01	AS	6	4	0	0	10
	Components 02/03	AS	0	0	10	0	10
2804		A2	7.5	7.5	0	0	15
2805	Components 01-05	A2	5	5	0	5	15
2806	Component 01	A2	0	0	0	10	10
	Components 02/03	A2	0	0	5	5	10
Total			36.5	28.5	15	20	100

3.2 Quality of Written Communication

The requirement for all AS and Advanced GCE specifications to assess candidates' quality of written communication is met through all four Assessment Objectives. Questions which provide an assessment of quality of written communication are included in question papers for Units 2801, 2802, 2803 (Component 1), 2804, 2805 (Components 01-05) and 2806 (Component 1), and in the assessment of experimental skills in Unit 2803, Components 02/03 and in Unit 2806, Components 02/03.

4 Scheme of Assessment

Candidates take three units for AS GCE, followed by a further three units at A2 if they are seeking an Advanced GCE award.

Units of Assessment

Level	Unit/ Component	Name	Duration	Mode of Assessment	Weighting	
					AS	Advanced GCE
AS	2801	Biology Foundation	1 hour	Written Examination	30%	15%
	2802	Human Health and Disease	1 hour	Written Examination	30%	15%
	2803	Transport/ Experimental Skills 1				
	/01	Transport	45 mins	Written Examination	20%	10%
	/02	Coursework 1	-	Coursework	20%	10%
	/03	Practical Examination 1	1 hour 30 mins	Practical Examination	20%	10%
A2	2804	Central Concepts	1 hour 30 mins	Written Examination	-	15%
	2805	Options in Biology (one of)				
	/01	Growth, Development and Reproduction	1 hour 30 mins	Written Examination	-	15%
	/02	Applications of Genetics	1 hour 30 mins	Written Examination	-	15%

Units of Assessment (continued)

Level	Unit/ Component	Name	Duration	Mode of Assessment	Weighting	
					AS	Advanced GCE
A2	/03	Environmental Biology	1 hour 30 mins	Written Examination	-	15%
	/04	Microbiology and Biotechnology	1 hour 30 mins	Written Examination	-	15%
	/05	Mammalian Physiology and Behaviour	1 hour 30 mins	Written Examination	-	15%
	2806	Unifying Concepts in Biology/ Experimental Skills 2				
	/01	Unifying Concepts in Biology	1 hour 15 mins	Written Examination	-	10%
	/02	Coursework 2	-	Coursework	-	10%
	/03	Practical Examination 2	1 hour 30 mins	Practical Examination	-	10%

In Unit 2803, candidates take **either** Components 01 and 02 or Components 01 and 03.

In Unit 2805, candidates take **one** of Components 01 – 05.

In Unit 2806, candidates take **either** Components 01 and 02 or Components 01 and 03.

For Units 2803 and 2806, **both** chosen assessment components **must** be taken in the same examination session.

If a candidate retakes Unit 2803 and/or Unit 2806 within 12 months, they have the opportunity to carry forward the mark for the coursework component (Component 02).

All candidates for Units 2803 and 2806 should be entered under the relevant unit code with one of the following option codes:

Option Code	Component to be taken	
A	01 02	Written examination Coursework
B	01 82	Written examination Coursework mark carried forward
C	01 03	Written examination Practical examination

All candidates for Unit 2805 should be entered under the relevant unit code with one of the following option codes.

Option Code	Component to be taken	
A	01	Growth, Development and Reproduction
B	02	Applications of Genetics
C	03	Environmental Biology
D	04	Microbiology and Biotechnology
E	05	Mammalian Physiology and Behaviour

Rules of Combination

Candidates must take the following combination of Units of Assessment:

AS GCE — Candidates take Units 2801, 2802 and 2803;

Advanced GCE — Candidates take units 2801, 2802, 2803, 2804, 2805 and 2806.

Unit Availability

There are two unit sessions each year, in January and June.

The availability of units is shown below.

Level	Unit	Unit Title	Jan	June
AS	2801	Biology Foundation	⌣	⌣
AS	2802	Human Health and Disease	⌣	⌣
AS	2803	Transport/ Experimental Skills 1	⌣	⌣
A2	2804	Central Concepts	⌣	⌣
A2	2805	Options in Biology	⌣	⌣
A2	2806	Unifying Concepts in Biology/Experimental Skills 2	⌣	⌣

Sequence of Units

The normal sequence in which the units could be taken is Units 2801, 2802 and 2803 in the first year of a course of study, leading to an AS GCE award, then Units 2804, 2805 and 2806 in the second year leading to the full Advanced GCE award. However, the units may be taken in other sequences.

Candidates may take all units at the end of their AS GCE or Advanced GCE course in a 'linear' manner, if desired.

Synoptic Assessment

Synoptic assessment involves the explicit drawing together of knowledge, understanding and skills learned in different parts of the Advanced GCE course. Assessment Objective AO4 relates specifically to synoptic assessment. It accounts for 20% of the total Advanced GCE marks and is assessed only in A2 Units 2805 and 2806. Units 2805 and 2806 should normally, therefore, be taken at the end of the course, but this is no longer a requirement.

Synoptic assessment:

- requires candidates to make and use connections between different areas of biology, for example, by applying knowledge of a number of areas to a particular situation or context;
- provides opportunities for candidates to use ideas and skills which permeate biology, for example, the analysis and evaluation of empirical data and other information in contexts which may be new to them.

Questions are set in the examination papers for Unit 2805 and Unit 2806, Component 01, which require candidates to demonstrate these abilities.

During experimental and investigative work, synoptic assessment:

- allows candidates to apply knowledge and understanding of principles and concepts of biology in planning experimental work and in the analysis and evaluation of data.

All practical work assessed internally by centres for the A2 coursework component (Unit 2806, Component 02) should draw on the range of experience that the candidate will have acquired during the AS course. It is particularly important that an exercise used to evaluate planning skills should involve an element of research which goes beyond the repetition of an experiment that simply reflects the use of ideas, or techniques, met within the module currently being studied. Likewise an assessment involving the analysing and evaluation of evidence must require a candidate to use knowledge and understanding acquired outside the confines of a standard experiment recently practised. During the process of moderation, evidence is sought that such breadth has been achieved.

Unit 2806, Component 02 and Component 03, therefore, include a degree of synoptic assessment.

Certification

Candidates may enter for:

- AS GCE certification;
- AS certification, bank the result, and complete the A2 assessment at a later date;
- Advanced GCE certification.

Candidates must enter the appropriate AS **and** A2 Units to qualify for the full Advanced GCE award.

Individual unit results, prior to certification of the qualification, have a shelf-life limited only by that of the qualification.

Re-sits of Units

The restrictions on re-sitting units have been removed, enabling candidates to re-take units more than once. Upon making an entry for certification, the best attempt will be counted towards the final award. This change applies to all candidates, including those who have already been entered for any units or full qualifications.

Re-sits of AS GCE and Advanced GCE

Candidates may still enter for the full qualification an unlimited number of times.

4.1 Question Papers

4.1.1 AS

Unit 2801 - Biology Foundation(1 hour) (60 marks)
Unit 2802 - Human Health and Disease(1 hour) (60 marks)

The question papers for Units 2801 and 2802 have a common format. They contain questions comprising both structured parts and parts which require more extended answers. The distribution of marks is approximately 50 marks for the structured parts and 10 marks for the extended answers. All questions on these examination papers are compulsory. Quality of written communication is assessed within those parts of the questions that require more extended answers.

Unit 2803 Component 01 – Transport (45 mins) (45 marks)

The question paper contains questions comprising both structured parts and a part that requires a more extended answer. The distribution of marks is approximately 38 marks for the structured parts and 7 marks for the extended answer. All questions on this examination paper are compulsory. Quality of written communication is assessed within the extended answer question.

Unit 2803 Component 03 – Practical Examination (1 hour 30 minutes) (60 marks)

The question paper consists of a Planning Exercise set by OCR and a Practical Test. Details of the Planning Exercise will be sent to Centres before the date of the Practical Test. The Practical Test consists of two questions. Question 1 is an experiment based on the physiology or biochemistry topics in the AS specification. This is broadly related to the Planning Exercise. Question 2 involves microscope work and candidates are expected to make their own temporary preparations of plant materials, or to use microscope slides or photographs supplied by OCR.

4.1.2 A2

Unit 2804 - Central Concepts (1 hour 30 minutes) (90 marks)
Unit 2805, Component 01- Growth, Development and Reproduction (1 hour 30 minutes) (90 marks)
Unit 2805, Component 02 - Applications of Genetics (1 hour 30 minutes) (90 marks)
Unit 2805, Component 03 - Environmental Biology (1 hour 30 minutes) (90 marks)
Unit 2805, Component 04 - Microbiology and Biotechnology (1 hour 30 minutes) (90 marks)
Unit 2805, Component 05 - Mammalian Physiology and Behaviour (1 hour 30 minutes) (90 marks)

The question papers for Unit 2804 and each component of Unit 2805 have the same format as the question papers for Units 2801 and 2802. They contain questions comprising both structured parts and parts which require more extended answers. The distribution of marks is approximately 65 marks for the structured parts and 25 marks for extended answers. All questions on these papers are compulsory. [Note: in Unit 2805 candidates answer questions in only one component.] Quality of written communication is assessed within those parts of the questions that require more extended answers. In each component in Unit 2805, approximately 30 marks are allocated to synoptic questions that require candidates to draw on their knowledge gained in the study of modules 2801, 2802, 2803 and 2804 to answer questions set in the context of the option concerned.

Unit 2806 Component 01 – Unifying Concepts in Biology (1 hour 15 minutes) (60 marks)

The question paper for Unit 2806, Component 01 comprises synoptic questions with both structured parts and parts requiring more extended answers. The distribution of marks is approximately 45 marks for the structured parts and 15 marks for the extended answers. All questions on this examination paper are compulsory. Quality of written communication is assessed within those parts of the questions that require more extended answers. The paper covers aspects of the AS specification and material studied in Module 2804 of the A2 specification. Details of the content that may be addressed in this paper are given in Section 5.10.

Unit 2806 Component 03 – Practical Examination (1 hour 30 minutes) (60 marks)

The question paper consists of a Planning Exercise set by OCR and a Practical Test. Details of the Planning Exercise will be sent to Centres before the date of the Practical Test. The Practical Test consists of two questions. Question 1 is an experiment based on the physiology or biochemistry topics in the A2 specification. This is broadly related to the Planning Exercise. Both the Planning Exercise and Question 1 require knowledge and understanding of Modules 2801 and 2803, Component 01, of the AS specification. Question 2 involves microscope work and candidates are expected either to make their own temporary preparations of plant materials, or to use microscope slides or photographs supplied by OCR.

4.2 Experimental and Investigative Skills

Experimental and Investigative skills may be assessed either **internally** (by coursework) or **externally** (by a combination of an externally marked task and a practical examination).

Entries are made for Unit 2803 (in AS) or 2806 (in A2). In each of these Units, candidates must take two components - a written paper (Component 01) and one of the above two assessments of experimental and investigative skills (i.e. Component 02 or Component 03). Both written paper and skills assessment components **must** be taken in the same examination session.

In Unit 2803, Component 02/03, marks contribute towards Assessment Objective AO3, Experiment and Investigation.

In Unit 2806, Component 02/03, marks contribute equally to Assessment Objectives AO3 and AO4, Synthesis of Knowledge, Understanding and Skills. There is assessment of AO4, because:

- candidates are required to use biological knowledge and understanding from other modules of the specification in planning their experimental and investigative work, and in analysing evidence and drawing conclusions;
- in the assessment of all four experimental skills in Unit 2806, Component 02, taken at the end of the course of study, candidates are expected to draw on their experience of such work throughout the course and, in particular, on the outcome of the assessment of these skills in Unit 2803, Component 02.

The Skills

The experimental and investigative skills to be assessed are:

Skill P: Planning

Candidates should:

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

Skill I: Implementing

Candidates should:

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

Skill A: Analysing Evidence and Drawing Conclusions

Candidates should:

- communicate biological information and ideas in appropriate ways, including tabulation, line graphs, histograms, continuous prose, annotated drawings and diagrams;
- recognise and comment on trends and patterns in data;
- understand the concept of statistical significance;
- draw valid conclusions by applying biological knowledge and understanding.

Skill E: Evaluating Evidence and Procedures.

Candidates should:

- assess the reliability and precision of experimental data and the conclusions drawn from it;
- evaluate the techniques used in the experimental activity, recognising their limitations.

Internal Assessment (Coursework option)

Unit 2803, Component 02 - Coursework 1 (60 Marks)
Unit 2806, Component 02 - Coursework 2 (60 Marks)

Assessment of candidates' experimental and investigative work as detailed above is made by the teacher (as coursework) and moderated externally by OCR.

Skills **P** and **A** are each marked out of 8 and Skills **I** and **E** are each marked out of 7. One mark per skill must be awarded for each candidate for AS (Unit 2803, Component 02) and for A2 (Unit 2806, Component 02). Hence, a raw mark out of 30 is initially calculated for each component. The marks are then doubled so that the final mark submitted for each component is out of 60.

In AS and in A2, the skills may be assessed in the context of separate practical exercises, although more than one skill may be assessed in any one exercise. They may also be assessed all together in the context of a single 'whole investigation' in which the task is set by the teacher, or by using individual investigations in which each candidate pursues his or her own choice of assignment.

The skills may be assessed at any time during the course using suitable practical activities, based on laboratory or field work, related to, or part of, the content of the teaching course. The context(s) for the assessment of the coursework for Unit 2803, Component 02 should be drawn from the content of AS Modules 2801, 2802 and 2803; the context(s) for the assessment of the coursework for Unit 2806, Component 02 should be drawn from the content of A2 Units 2804 and 2805, in which the level of demand of the related scientific knowledge and understanding is higher.

A similar set of mark descriptors is used for both AS and A2 (see Appendix C). These descriptors have been written to provide clear continuity from the assessment of Sc1 in GCSE Science. The difference in standard of AS and A2 is a product of the level of demand of the related scientific knowledge and understanding together with the complexity and level of demand of the tasks set. Also, the mark descriptors for skills **P** and **A** at A2 include synoptic elements (see Appendix B).

The length of time to be devoted to the assessment of experimental and investigative skills is entirely at the discretion of the teacher. It is anticipated that between 5 to 10 hours of class time should be sufficient in each of AS and A2.

Notes for Guidance on Coursework assessment and submission are given in Appendix B. Mark descriptors for the experimental and investigative skills are fully detailed in Appendix C.

Further details, including copies of relevant coursework forms, are given in the AS/A *Biology Teacher Support : Coursework Guidance Handbook*, copies of which can be ordered from the OCR Publications Department.

External Assessment (Practical Examination option)

Unit 2803, Component 03 - Practical Examination 1 (1 hour 30 minutes) (60 Marks)
Unit 2806, Component 03 - Practical Examination 2 (1 hour 30 minutes) (60 Marks)

External assessment of Experimental and Investigative Skills addresses the same skills as those covered by the Coursework option.

Skill P: Planning

Skill **P** is assessed using an OCR-set exercise which is externally marked. Candidates are asked to plan an investigation, set by OCR, in the context of the modules they have studied. Thus, for the AS Unit 2803, Component 03, the exercise is set in the context of the content covered in Modules 2801, 2802 and 2803, Component 01; for the A2 Unit 2806, Component 03, the exercise is set in the context of the content covered in 2804.

Candidates will be given the Planning Exercise, at a date, which will be published on the examination timetable, before the date of the Practical Test. The work must be handed in on, or before, the day of the Practical Test, at the discretion of the Centre. The Centre is required to despatch this work to the OCR Examiner with the Practical Test scripts and the work must, therefore, be kept securely until the day of the examination. Candidates may be given access, if they request it and at the discretion of the Centre, to laboratory space and facilities in order to be able to carry out preliminary work which will help in constructing their plan. It should be noted that the responsibility for health and safety during this period rests with the Centre, and the attention of teachers is drawn to the notes in Appendix B. Access to suitable library and other resources is also required and, while time at home or in private study may be necessary to complete the task to a high standard, sufficient work must be completed under direct supervision to allow the teacher to authenticate the work with confidence as that of the candidates concerned.

It should be recognised that the Planning Exercises contribute just 2.5% to the full Advanced GCE Level for each of the AS and A2 assessments. Candidates should thus be guided to spend an appropriate amount of time on the work and it is suggested that they should be given between 7-10 days to complete it. Candidates' work should be no more than 1000 words.

If a candidate is given guidance during the period in which the exercise has to be completed, this must be recorded.

The mark scheme for the Planning Exercise is closely based on the coursework mark descriptors for Skill **P**, given in Appendix C, and a copy of these descriptors should be provided to candidates to assist them in their work.

Skill I: Implementing

Skill A: Analysing Evidence and Drawing Conclusions

Skill E: Evaluating Evidence and Procedures.

Skills **I**, **A** and **E** are assessed in the Practical Test itself which consists of two questions. Candidates are required to carry out a practical experiment (Question 1) which will be set in the same general context as that used for the Planning Exercise, but will **not** be the same task. Thus, while the research work carried out for the Planning Exercise may assist candidates in their interpretation of the results of the experiment in Question 1 they are **not** asked to carry out the investigation they have planned. Question 2 in the Practical Test involves microscope work and candidates are expected either to make their own temporary preparations of plant material or to use microscope slides or photographs supplied by OCR.

Skill **I** is assessed on the conduct of the experiment, the use of the microscope, and the observations and/or measurements taken. Skills **A** and **E** are assessed on candidates' analysis and evaluation of the results of the experiment and microscope work, together with other data and information given in the paper itself.

The mark scheme for the paper is closely based on the coursework mark descriptors for these skills (see Appendix C) and teachers are recommended to draw these to the attention of candidates in their preparation for the paper.

Practical Instructions containing details of the apparatus and/or materials required for the practical examination are sent to Centres before the date of the examination. Centres should contact OCR if the Instructions are not received. It is essential that confidentiality is maintained prior to the date of the examination.

Further details concerning the administration and conduct of this assessment option are given in Appendix E.

4.2.1 Experimental and Investigative Work at AS and A2

The assessment descriptors given in Appendix C are used for the assessment of coursework in both AS and A2. The mark schemes for the practical examinations are also based on these descriptors which are similar for both AS and A2 components.

Assessments at AS and A2 are differentiated by the complexity of the tasks set and the contexts of the underlying scientific knowledge and understanding. In A2, candidates are required to apply knowledge, understanding and skills from the AS and A2 parts of the specification in planning experimental work and in the analysis of results to reach conclusions.

At AS, experimental and investigative work is likely to be qualitative or require processing in a context that is familiar to candidates.

- **Planning** exercises, although novel, focus on apparatus and techniques which have previously been encountered, based on knowledge and understanding from a limited part of the AS specification.
- **Implementing** involves the manipulation of simple apparatus and the application of easily recognised safety procedures.
- **Analysing and concluding** involve simple data handling, reaching conclusions based on a limited part of the AS specification.
- **Evaluation** expects recognition of the main sources of error and direct methods for improving accuracy.

At A2, assessments expect a greater level of sophistication and higher levels of skill.

- **Planning** exercises require research to provide a satisfactory solution to a problem which can be addressed in more than one way. The underlying knowledge, understanding and skills are likely to be drawn from several different parts of the AS and A2 specifications.
- **Implementing** involves a detailed risk assessment and the careful use of sophisticated techniques or apparatus to obtain results that are precise and reliable.
- **Analysing and concluding** involve sophisticated data handling and the synthesis of several strands of evidence. In developing conclusions, candidates will have the opportunity to demonstrate their skills in drawing together principles and concepts from different parts of the AS and A2 specifications.
- **Evaluation** requires recognition of the key experimental limitations and other sources of error as well as an understanding of the methods that may be used to limit their effect. The evaluation is likely to draw together principles and concepts from different parts of the specification.

Detailed advice on the choice of experimental and investigative work suitable for AS and A2, and guidance on the application of the assessment descriptors to exemplar tasks, are provided in the *AS/A Biology Teacher Support : Coursework Guidance Handbook*, which can be ordered from the OCR Publication Department.

4.2.2 Assessment and Moderation

Coursework in Unit 2803 Component 02 and Unit 2806 Component 02 is marked by the teacher and internally standardised by the Centre. Marks are then submitted to OCR by a specified date, after which postal moderation takes place in accordance with OCR procedures. The purpose of moderation is to ensure that the standard for the award of marks in coursework is the same for each Centre, and that each teacher has applied the standards appropriately across the range of candidates within the Centre.

Coursework submissions should be clearly annotated by the Centre to support the marks awarded to the candidates.

The sample of work that is submitted to the Moderator for moderation must show how the marks have been awarded in relation to the marking criteria.

4.2.3 Minimum Coursework Requirements

If no work is submitted by a candidate for a coursework component (Unit 2803 Component 02 and/or Unit 2806 Component 02), the candidate should be indicated as being absent from that component on the coursework mark sheets submitted to OCR. Any work submitted by a candidate should be assessed according to the mark descriptors and marking instructions and the appropriate mark awarded, which may be 0 (zero).

4.2.4 Authentication of Coursework

As with all coursework, the teacher must be able to verify that the work submitted for assessment is the candidate's own. Sufficient work must be carried out under direct supervision to allow the teacher to authenticate the coursework marks with confidence.

4.3 Special Arrangements

For candidates who are unable to complete the full assessment, or whose performance may be adversely affected through no fault of their own, teachers should consult the *Inter-Board Regulations and Guidance Booklet for Special Arrangements and Special Consideration*. In such cases, advice should be sought from OCR as early as possible during the course. Applications for special consideration in coursework components should be accompanied by Coursework Assessment Forms giving the breakdown of marks for each skill.

4.4 Differentiation

In the question papers, differentiation is achieved by setting questions which are designed to assess candidates at their appropriate levels of ability and which are intended to allow all candidates to demonstrate what they know, understand and can do.

In coursework, differentiation is by task and by outcome. Candidates will undertake assignments which enable them to display positive achievement.

4.5 Awarding of Grades

The AS has a weighting of 50% when used in an Advanced GCE award. An Advanced GCE award is based on the certification of the weighted AS (50%) and A2 (50%) marks.

Both AS GCE and Advanced GCE qualifications are awarded on the scale A to E, or U (unclassified).

4.6 Grade Descriptions

The following grade descriptions indicate the level of attainment characteristic of the given grade at Advanced GCE. They give a general indication of the required learning outcomes at each specified grade. The descriptions should be interpreted in relation to the content outlined in the specifications; 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 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 scientific 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 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 scientific 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 scientific knowledge and understanding and, with help, evaluate their results. They comment on data and use selected data to support a particular hypotheses. 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 scientific 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 calculations. They apply knowledge and scientific 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 include irrelevant material. They use correctly a limited range of scientific 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.

5 Specification Content

Throughout this section the symbol  is used in the margin to highlight where Key Skills development opportunities are signposted. For more information on Keys Skills coverage please refer to Appendix A.

5.1 Module 2801: Biology Foundation

Preamble

This module is intended to act as a foundation unit for the AS Biology specification. In particular it provides:

- an understanding of some fundamental concepts, techniques and procedures in biology;
- an opportunity for the candidate to become familiar with controlling variables and using the light microscope;
- an understanding of nutrient cycling within ecosystems;
- a basis for the further study of biology within the scheme.

Assessment Objectives

See Section 3. Candidates are expected to apply knowledge, understanding and other skills gained in this module to new situations and/or to solve related problems.

Recommended Prior Knowledge

Candidates should

- have achieved Grade CC or above in GCSE Science: Double Award (or equivalent in Science: Biology).

5.1.1 Cell Structure

C3.1b; N3.1, N3.2, N3.3; IT3.1, IT3.3

WO3.1, WO3.2, WO3.3; LP3.1, LP3.2, LP3.3.

Recommended Prior Knowledge

Candidates should have a knowledge of

- Key Stage 4 Programme of Study Sc2, 1 a, b, c and e.

Content

- Cells as the basic units of living organisms grouped into tissues and organs.
- Characteristics of eukaryotic and prokaryotic cells.
- Detailed structure of typical animal and plant cells as seen under the light and electron microscope.
- Outline functions of organelles in plant and animal cells.

Learning Outcomes

Candidates should be able to:

(a) explain and distinguish between resolution and magnification with reference to light microscopy and electron microscopy.

(b) describe and interpret drawings and photographs of typical animal and plant cells as seen using the light microscope.

(c) describe and interpret drawings and photographs of typical animal and plant cells as seen using the electron microscope, recognising the following: rough and smooth endoplasmic reticulum, Golgi apparatus, mitochondria, ribosomes, lysosomes, chloroplasts, plasma (cell surface) membrane, nuclear envelope, centrioles, nucleus, nucleolus and cilia. **C3.1b, IT3.3, WO3 (all), LP3 (all)**

(d) outline the functions of the structures listed in (c). **C3.1b, IT3.3, WO3 (all), LP3 (all)**

(e) describe the structure of a prokaryotic cell and compare and contrast the structure of prokaryotic cells with eukaryotic cells.

(f) explain how cells are organised into tissues with reference to squamous and ciliated epithelia, xylem and phloem.

(g) explain the meaning of the terms tissue and organ, and state examples in animals and plants.

(h) draw plan diagrams of tissues (including a transverse section of a mesophytic dicotyledonous leaf) and calculate the linear magnification of drawings.

N3 (all), LP3 (all)

5.1.2 Biological Molecules

C3.1b; IT3.3.

WO3.1, WO3.2, WO3.3.

Recommended Prior Knowledge

Candidates should have a knowledge of

- Key Stage 4 Programme of Study Sc2, 1a and c.

Content

- The structure of carbohydrates, lipids and proteins and their roles in living organisms.
- Water and living organisms.
- The roles of inorganic ions.

Learning Outcomes

Candidates should be able to:

(a) carry out tests for reducing and non-reducing sugars (including semi-quantitative use of the Benedict's test), the iodine in potassium iodide solution test for starch, the emulsion test for lipids, and the biuret test for proteins.

(b) describe the structures of the ring forms of alpha and beta glucose. **C3.1b, IT3.3, WO3 (all)**

(c) describe the formation and breakage of a glycosidic bond. **C3.1b, IT3.3, WO3 (all)**

(d) describe the molecular structure of starch (amylopectin and amylose), glycogen and cellulose, and relate these structures to their functions in living organisms. **C3.1b, IT3.3, WO3 (all)**

(e) describe the molecular structure of a triglyceride and a phospholipid, and relate these structures to their functions in living organisms.

(f) describe the structure of an amino acid, and the formation and breakage of a peptide bond.

(g) explain the meaning of the terms **primary structure, secondary structure, tertiary structure** and **quaternary structure** of proteins, and describe the types of bonding (hydrogen, ionic, disulphide and hydrophobic interactions) which hold the molecule in shape.

(h) outline the molecular structure of haemoglobin as an example of a globular protein, and of collagen as an example of a fibrous protein, and relate these structures to their functions. (The importance of iron in the haemoglobin molecule should be emphasised.)

(i) describe and explain the roles of water in living organisms and as an environment for organisms. (Reference should be made to hydrogen bonding.)

(j) state one role of each of the following inorganic ions in living organisms: calcium, sodium, potassium, magnesium, chloride, nitrate, phosphate.

5.1.3 Enzymes

C3.2; IT3.2; N3.1, N3.2, N3.3

Recommended Prior Knowledge

Candidates should have a knowledge of:

- Key stage 4 Programme of Study Sc2, 1a and 2b.

Content

- Mode of action of enzymes.

Learning Outcomes

Candidates should be able to:

(a) explain that enzymes are globular proteins which catalyse metabolic reactions.

(b) explain the mode of action of enzymes in terms of an active site, enzyme/substrate complex, lowering of activation energy and enzyme specificity. **3.2**

(c) describe and explain the effects of pH, temperature, enzyme concentration and substrate concentration on enzyme action. **T3.2**

(d) follow the time course of an enzyme-catalysed reaction by measuring rates of formation of products (for example using catalase), or rate of disappearance of substrate (for example using amylase). **3.2, IT3.2, N3 (all)**

(e) explain the effects of reversible inhibitors (both competitive and non-competitive) on the rate of enzyme activity.

5.1.4 Cell Membranes and Transport

Recommended Prior Knowledge

Candidates should have a knowledge of

- Key stage 4 Programme of Study Sc2, 1 a and d.

Content

- The fluid mosaic model of membrane structure.
- The movement of substances into and out of cells.

Learning Outcomes

Candidates should be able to:

(a) describe and explain the fluid mosaic model of membrane structure, including an outline of the roles of phospholipids, cholesterol, glycolipids, proteins and glycoproteins.

(b) outline the roles of membranes within and at the surface of cells.

(c) describe and explain the processes of osmosis, passive diffusion, facilitated diffusion, active transport, endocytosis and exocytosis. (The terminology described in the IOB publication *Biological Nomenclature* should be used: **no** calculations involving water potential will be set.)

(d) describe the features of the gaseous exchange surface of the mammalian lung.

(e) describe the features of root hairs (including carrier molecules in membranes which enable the uptake of ions by active transport).

5.1.5 Genetic Control of Protein Structure and Function

LP3.1, LP3.2, LP3.3; PS3.1, PS3.2, PS3.3

Recommended Prior Knowledge

Candidates should have a knowledge of

- Key Stage 4 Programme of Study Sc2,1 a, e and f, 4 g and h.

Content

- The structure and replication of DNA.
- The roles of DNA and RNA in protein synthesis.
- The principles of gene manipulation

Learning Outcomes

Candidates should be able to:

(a) describe the structures of DNA and RNA, and explain the importance of base pairing and hydrogen bonding.

(b) explain how DNA replicates semi-conservatively during interphase, and interpret experimental evidence for this process. (Reference should be made to DNA polymerase.)

(c) state that a gene is a sequence of nucleotides as part of a DNA molecule, which codes for a polypeptide.

(d) describe the way in which the nucleotide sequence codes for the amino acid sequence in a polypeptide. **S3 (all), LP3 (all)**

(e) describe how the information on DNA is used to construct polypeptides, including the role of messenger RNA, transfer RNA and the ribosomes. **S3 (all), LP3 (all)**

(f) explain that, as enzymes are proteins, their synthesis is controlled by DNA.

(g) outline the general principles of gene manipulation by biotechnology, with reference to the synthesis of human insulin by bacteria and human factor VIII.

5.1.6 Nuclear Division

N3.3

Recommended Prior Knowledge

Candidates should have a knowledge of

- Key Stage 4 Programme of Study Sc2, 1 e and f, 4 a and b.

Content

- Replication and division of nuclei.
- Chromosome behaviour in mitosis.
- The need for a reduction division in sexual reproduction.

Learning Outcomes

Candidates should be able to:

(a) explain how growth, repair and asexual reproduction in animals and plants can be brought about by mitosis.

(b) explain the need for the production of genetically identical cells.

(c) explain how cancer is the result of uncontrolled cell division, and list factors that can increase the chances of cancerous growth.

(d) describe, with the aid of diagrams, the behaviour of chromosomes during the mitotic cell cycle, and the associated behaviour of the nuclear envelope, cell membrane and centrioles. (Names of the main stages are expected.) **N3.3**

(e) explain what is meant by homologous pairs of chromosomes.

(f) explain the meaning of the terms haploid and diploid, and the need for a reduction division prior to fertilisation in sexual reproduction. (Details of meiosis are not expected.)

5.1.7 Energy and Ecosystems

IT3.2

Recommended Prior knowledge

Candidates should have a knowledge of

- Key Stage 4 Programme of Study Sc2, 5 c, d and e.

Content

- Energy transfer through an ecosystem.
- The nitrogen cycle.

Learning Outcomes

Candidates should be able to:

(a) define the terms **habitat, niche, population, community** and **ecosystem**, and state examples of each.

(b) explain the terms **producer, consumer** and **trophic level**.

(c) describe how energy is transferred though food chains and food webs, and discuss the efficiency of this transfer between trophic levels. **IT3.2**

(d) describe how nitrogen is cycled within an ecosystem. (Reference should be made to the roles of microoganisms, but only *Nitrosomonas, Nitrobacter* and *Rhizobium* need to be identified by name.)

5.2 Module 2802: Human Health and Disease

Preamble

In addition to meeting the aims of the specification as a whole, this module is intended to develop:

- an understanding of what is meant by health and disease;
- an appreciation of disease in a global context and the factors that affect patterns of disease globally;
- an understanding of the principles upon which preventive medicine is based; an understanding of the extent to which people can influence their health by their behaviour;
- an appreciation of the role and implications of medical technology in the context of limited resources;
- an understanding of how our bodies attempt to maintain good health;
- a positive attitude and approach to health as being more than simply the absence of disease.

Assessment Objectives

See Section 3. Candidates are expected to appy knowledge, understanding and other skills gained in this module to new situations and/or to solve related problems.

Recommended Prior Knowledge

Candidates should have a knowledge of

- Key Stage 4 Programme of Study Sc.2, 2 a - g, m, n, p, q and r;
- Biology Foundation, Module 2801;
- Transport, Module 2803, Component 01, sections 5.3.1 and 5.3.2.

5.2.1 Introduction to Health and Disease

IT3.1, IT3.3

Recommended Prior Knowledge

Candidates should have a knowledge of

- Key Stage 4 Programme of Study Sc2, 2d-g,m,n,q and r;
- Biology Foundation, Module 2801;
- Transport, Module 2803, Component 01, sections 5.3.1 and 5.3.2.

Content

- Definitions of the terms **health** and **disease**.
- Global patterns of disease distribution.

Learning Outcomes

Candidates should be able to:

(a) discuss what is meant by the terms **health** and **disease**.

(b) discuss whether health is more than simply the absence of disease.

(c) explain, with one example of each, what is meant by the following categories of disease or illness: physical, mental, social, infectious, non-infectious, degenerative, inherited, self-inflicted and deficiency.

(d) explain the reasons for collecting health statistics. **T3.1, IT3.3**

(e) describe and explain the differences between standards of health in developed and developing countries.

(f) explain the terms **pandemic, epidemic** and **endemic**.

(g) appreciate the significance of the Human Genome Project to human health and disease.

5.2.2 Diet

C3.1a

Recommended Prior Knowledge

Candidates should have knowledge of

- Key Stage 4 Programme of Study Sc2, 2 a and b;
- Biology Foundation, Module 2801;
- Transport, Module 2803, Component 01, sections 5.3.1 and 5.3.2.

Content

- The concept of the balanced diet.
- Energy and nutrient requirements.
- Essential nutrients.
- The consequences of malnutrition.
- Diet and coronary heart disease.

Learning Outcomes

Candidates should be able to:

(a) list the components of a balanced diet.

(b) discuss the energy and nutrient requirements of people with reference to gender, age, activity, pregnancy and lactation.

(c) explain what is meant by the term **dietary reference value** (DRV) and describe how these values should be used. (The Department of Health publication *Dietary Reference Values for Food Energy and Nutrients for the UK, 1991* should be consulted.)

(d) describe the functions of essential amino acids, essential fatty acids and vitamins A and D in the body.

(e) describe the consequences of malnutrition with reference to energy and protein deficiency, anorexia nervosa, deficiencies of vitamins A and D, and obesity.

(f) discuss the possible links between diet and coronary heart disease. **3.1a**

5.2.3 Gaseous Exchange and Exercise

LP3.1, LP3.2, LP3.3; PS3.1, PS3.2, PS3.3

Recommended Prior Knowledge

Candidates should have a knowledge of

- Key Stage 4 Programme of Study Sc2, 2 d-g, m-p;
- Biology Foundation, Module 2801;
- Transport, Module 2803, Component 01, sections 5.3.1 and 5.3.2.

Content

- The gaseous exchange system.
- The consequences of exercise.

Learning Outcomes

Candidates should be able to:

(a) describe the distribution of alveoli and blood vessels in lung tissue.

(b) describe the distribution of cartilage, ciliated epithelium, goblet cells and smooth muscle in the trachea, bronchi and bronchioles.

(c) describe the functions of cartilage, cilia, goblet cells, smooth muscle and elastic fibres in the gaseous exchange system.

(d) explain the meanings of the terms **tidal volume** and **vital capacity**;

(e) measure their pulse rate and understand that pulse rate is a measure of heart rate.

(f) explain the significance of resting pulse rate in relation to physical fitness.

(g) explain the terms **systolic blood pressure, diastolic blood pressure** and **hypertension**.

(h) explain the meaning of the term **aerobic exercise**.

(i) describe the immediate effects of exercise on the body, including the concept of oxygen debt and the production of lactate by anaerobic respiration.

(j) design and carry out experiments to investigate the effects of exercise on the body. (**Teachers should satisfy themselves that any exercise undertaken by candidates can be done safely.**) **S3 (all), LP3 (all)**

(k) appreciate how much exercise needs to be taken for significant sustained improvement in aerobic fitness. **S3 (all), LP3 (all)**

(l) discuss the long-term consequences of exercise on the body and the benefits of maintaining a physically fit body, relating these benefits to the concept that health is more than the absence of disease. **S3 (all), LP3 (all)**

5.2.4 Smoking and disease

C3.2

Recommended Prior Knowledge

Candidates should have knowledge of

- Key Stage 4 Programme of Study Sc2, 2 c-e ,q and r;
- Biology Foundation, Module, 2801;
- Transport, Module 2803, Component 01, sections 5.3.1 and 5.3.2.

Content

- Effects of smoking and disease on the gaseous exchange and cardiovascular systems.
- Prevention and cure.

Learning Outcomes

Candidates should be able to:

(a) describe the effects of tar and carcinogens in tobacco smoke on the gaseous exchange system.

(b) describe the symptoms of chronic bronchitis and emphysema (chronic obstructive pulmonary disease) and lung cancer.

(c) evaluate the epidemiological and experimental evidence linking cigarette smoking to disease and early death. **C3.2**

(d) describe the effects of nicotine and carbon monoxide in tobacco smoke on the cardiovascular system with reference to atherosclerosis, coronary heart disease and strokes.

(e) discuss the reasons for the global distribution of coronary heart disease.

(f) discuss the difficulty in achieving a balance between prevention and cure, with reference to coronary heart disease, coronary by-pass surgery and heart transplant surgery.

5.2.5 Infectious Diseases

Recommended Prior Knowledge

Candidates should have knowledge of

- Key Stage 4 Programme of Study Sc2, 2 a-f, m, p and q;
- Biology Foundation, Module 2801;
- Transport, Module 2803, Component 01, section 5.3.1.

Content

- Cholera, malaria, tuberculosis (TB) and AIDS.
- Antibiotics.

Learning Outcomes

Candidates should be able to:

(a) describe the causes and means of transmission of cholera, malaria, AIDS/HIV and TB. (Knowledge of the symptoms of these diseases is **not** required.)

(b) assess the worldwide importance of these diseases.

(c) describe the roles of social, economic and biological factors in the prevention and control of these diseases.

(d) outline the role of antibiotics in the treatment of infectious disease.

5.2.6 Immunity

WO3.1, WO3.2, WO3.3

Recommended Prior Knowledge

Candidates should have a knowledge of

- Key Stage 4 Programme of Study Sc2, 2 c and q;
- Biology Foundation, Module 2801;
- Transport, Module 2803, Component 01, section 5.3.1.

Content

- The immune system.
- The role of vaccination in controlling disease.

Learning Outcomes

Candidates should be able to:

(a) describe the origin, maturation and mode of action of phagocytes and lymphocytes.

(b) explain the meaning of the term **immune response**.

(c) distinguish between the actions of B lymphocytes and T lymphocytes in fighting infection.

(d) appreciate the role of memory cells in long-term immunity.

(e) relate the molecular structure of antibodies to their functions. **WO3 (all)**

(f) vaccination can control disease.

(g) discuss the reasons why vaccination has eradicated smallpox but not measles, TB, malaria or cholera.

(h) outline the role of the immune system in allergies, with reference to asthma and hay fever.

5.3 Module 2803, Component 01: Transport

Preamble

In addition to meeting the aims of the specification as a whole, this component is intended to develop an understanding of the transport mechanisms in mammals and flowering plants.

Assessment Objectives

See Section 3. Candidates are expected to apply knowledge, understanding and other skills gained in this component to new situations and/or to solve related problems.

Recommended Prior Knowledge

Candidates should have a knowledge of

- Key Stage 4 programme of Study Sc2, 1 b and d, 2 c-f, 3 c,f,g and h;
- Biology Foundation, Module 2801.

5.3.1 The Mammalian Transport System

Recommended Prior Knowledge

Candidates should have a knowledge of

- Key Stage 4 Programme of Study Sc2, 1 b, 2 c and d;
- Biology Foundation, Module 2801, sections 5.1.1 and 5.1.4.

Content

- The need for a transport system in multicellular animals.
- Transport in mammals.

Learning Outcomes

Candidates should be able to:

(a) explain the need for transport systems in multicellular animals in terms of size and surface area to volume ratios.

(b) describe the structures of arteries, veins and capillaries and be able to recognise these vessels using the light microscope.

(c) explain the relationship between the structure and function of arteries, veins and capillaries.

(d) describe the structure of red blood cells, phagocytes and lymphocytes, and explain the differences between blood, tissue fluid and lymph.

(e) describe gaseous exchange in the alveoli.

(f) describe the role of haemoglobin in carrying oxygen and carbon dioxide.

(g) describe and explain the significance of the dissociation curves of adult oxyhaemoglobin at different carbon dioxide levels (the Bohr effect).

(h) explain the significance of the different affinities of fetal haemoglobin and adult haemoglobin for oxygen.

(i) describe and explain the significance of the increase in the red blood cell count of humans at high altitude.

5.3.2 The Mammalian Heart

Recommended Prior Knowledge

Candidates should have a knowledge of

- Key Stage 4 Programme of Study Sc2, 1 b and 2 c;
- Biology Foundation, Module 2801, sections 5.1.1.

Content

- The structure and functioning of the mammalian heart.

Learning Outcomes

Candidates should be able to:

(a) describe the external and internal structure of the mammalian heart.

(b) explain the differences in the thickness of the walls of the different chambers in terms of their functions.

(c) describe the mammalian circulatory system as a closed double circulation.

(d) describe the cardiac cycle.

(e) explain how heart action is initiated. (Reference should be made to the sino-atrial node, the atrio-ventricular node and the Purkyne tissue.)

5.3.3 Transport in Multicellular Plants

N3.2

Recommended Prior Knowledge

Candidates should have knowledge of

- Key Stage 4 Programme of Study Sc2, 1 b and d, 3 c, f, g and h;
- Biology Foundation, Module 2801, sections 5.1.1 and 5.1.4.

Content

- The need for, and functioning of, a transport system in multicellular plants.

Learning Outcomes

Candidates should be able to:

(a) explain the need for transport systems in multicellular plants in terms of size and surface area to volume ratios.

(b) define the term **transpiration** and explain that it is an inevitable consequence of gaseous exchange in plants.

(c) describe how to investigate experimentally the factors which affect transpiration rate.

N3.2

(d) describe the distribution of xylem and phloem tissue in roots, stems and leaves of dicotyledonous plants.

(e) describe the structure of xylem vessels, sieve tube elements and companion cells, and be able to recognise these using the light microscope.

(f) relate the structure of xylem vessels, sieve tube elements and companion cells to their functions.

(g) explain the movement of water between plant cells and between them and their environment, in terms of water potential. (**No** calculations involving water potential will be set.)

(h) describe the pathway and explain the mechanism by which water is transported from roots to leaves.

(i) explain translocation as an energy-requiring process transporting assimilates, especially sucrose, between the leaves (sources) and other parts of the plant (sinks).

(j) describe **one** possible mechanism of transport in phloem, and the evidence for and against the mechanism.

(k) describe how the leaves of xerophytes are adapted to reduce water loss by transpiration.

N3.2

5.4 Module 2804: Central Concepts

Preamble

In addition to meeting the aims of the specification as a whole, this module is intended to develop:

- an understanding of energy transfer within and between organisms;
- an understanding of population dynamics;
- an understanding of the central role of DNA in living organisms;
- an understanding of the way in which selection may lead to evolution;
- provide an understanding of excretion in mammals;
- provide an understanding of control and communication within mammals and within flowering plants.

Assessment Objectives

See Section 3. Candidates are expected to apply knowledge, understanding and other skills gained in this module to new situations and/or to solve related problems. The content of this module will be assessed in Unit 2804 and Unit 2806, Component 01.

Recommended Prior Knowledge

Candidates should have a knowledge of

- Key Stage 4 Programme of Study Sc.2, 5 a, e and f;
- Biology Foundation, Module 2801;
- Transport, Module 2803, Component 01.

5.4.1 Energy and Respiration

C3.3; IT3.2.; LP3.1, LP3.2, LP3.3; PS3.1, PS3.2, PS3.3

Recommended Prior Knowledge

Candidates should have knowledge of

- Biology Foundation, Module 2801, sections 5.1.1, 5.1.2, 5.1.3, and 5.1.4.

Content

- The need for energy in living organisms.
- Respiration as an energy transfer process.
- Aerobic respiration.
- Anaerobic respiration.

Learning Outcomes

Candidates should be able to:

(a) outline the need for energy in living organisms as illustrated by anabolic reactions, active transport, movement and the maintenance of body temperature.

(b) describe the structure of ATP as a phosphorylated nucleotide.

(c) describe the universal role of ATP as the energy currency in all living organisms.

(d) explain that the synthesis of ATP is associated with the electron transport chain on the membranes of the mitochondrion.

(e) outline glycolysis as phosphorylation of glucose and the subsequent splitting of hexose phosphate (6C) into two triose phosphate molecules which are then further oxidised with a small yield of ATP and reduced NAD.

(f) explain that, when oxygen is available, pyruvate is converted into acetyl (2C) coenzyme A, which then combines with oxaloacetate (4C) to form citrate (6C).

(g) outline the Krebs cycle, explaining that citrate is reconverted to oxaloacetate in a series of small steps in the matrix of the mitochondrion. (**No** further details are required.)

(h) explain that these processes involve decarboxylation and dehydrogenation, and describe the role of NAD. **PS3 (all), LP3 (all)**

(i) outline the process of oxidative phosphorylation, including the role of oxygen. (No details of the carriers are required.)

(j) explain the production of a small yield of ATP from anaerobic respiration and the formation of ethanol in yeast and lactate in mammals. **C3.3, IT3.2, PS3 (all), LP3 (all)**

(k) substrates.

(l) define the term **respiratory quotient** (RQ).

(m) carry out investigations, using simple respirometers, to measure RQ and the effect of temperature on respiration rate. **PS3 (all), LP3 (all)**

5.4.2 Photosynthesis

C3.3

Recommended Prior Knowledge

Candidates should have knowledge of

- Biology Foundation, Module, 2801, sections 5.1.1, 5.1.2, 5.1.3 and 5.1.4;
- Transport, Module 2803, Component 01, section 5.3.3.

Content

- Photosynthesis as an energy transfer process.

Learning Outcomes

Candidates should be able to:

(a) explain that energy transferred as light is used during photosynthesis to produce complex organic molecules, and that the process of respiration allows this energy to be transferred through chemical reactions so that it can be used by living organisms.

(b) describe the photoactivation of chlorophyll resulting in the splitting of water molecules and in the transfer of energy to ATP and reduced NADP. (Cyclic and non-cyclic photophosphorylation should be described, but **no** biochemical **detail** is required.)

(c) describe the uses of ATP and reduced NADP in the light independent stage of photosynthesis.

(d) describe in outline the Calvin cycle involving the light independent fixation of carbon dioxide by combination with a 5C compound (RuBP) to yield two molecules of a 3C compound GP (PGA), and the conversion of GP into carbohydrates, lipids and amino acids.(The regeneration of RuBP should be understood in outline only, and a knowledge of C4 and CAM plants is **not** required.)

(e) describe the structure of a dicotyledonous leaf, a palisade cell and a chloroplast, and relate their structures to their roles in photosynthesis.

(f) discuss limiting factors in photosynthesis, and carry out investigations on the effects of light, carbon dioxide and temperature on the rate of photosynthesis. **C3.3**

5.4.3 Populations and Interactions

N3.1, N3.2, N3.3; IT3.1, IT3.2.

Recommended Prior Knowledge

Candidates should have knowledge of

- Key Stage 4 Programme of Study Sc2, 5 a, e and f;
- Biology Foundation, Module 2801, section 5.1.7.

Content

- Ecosystems are dynamic and subject to change.
- The effect of human activities on the environment.
- Management of an ecosystem to provide resources.

Learning Outcomes

Candidates should be able to:

(a) describe and explain sigmoidal population growth in a bacterial culture. **N3 (all),IT3.1, IT 3.2**

(b) explain, and give examples of, the significance of limiting factors in determining the final size of a population. **IT3.1, IT 3.2**

(c) explain the meaning of the term **carrying capacity**.

(d) describe **one** example of a predator-prey relationship and its possible effect on population size of both the predator and the prey.

(e) describe, and give examples of, inter- and intraspecific competition.

(f) explain the effects of interspecific competition on the distribution and population size of **two named** species.

(g) describe **one** example of primary succession resulting in a climax community. (The effects of **named** organisms on the succession should be considered.)

(h) investigate the distribution and abundance of **named** organisms in a specific habitat, using quadrats, point quadrats and transects.

(i) discuss the possible conflicts of interest between production and conservation. (Reference should be made to the use and effects of nitrogen-containing fertilisers, and to alternatives to their use.)

(j) explain how the management of an ecosystem can provide resources in a sustainable fashion, with reference to timber production in a temperate country.

5.4.4 Meiosis, Genetics and Gene Control

IT3.2

Recommended Prior Knowledge

Candidates should have a knowledge of

- Biology Foundation, Module 2801, section 5.1.5.

Content

- Replication and division of nuclei.
- Chromosome behaviour in meiosis.
- Effect of meiosis on variation.
- Monohybrid and dihybrid crosses.
- Effects of mutation and environment on the phenotype.
- Regulation of protein synthesis.
- The Human Genome Project.

Learning Outcomes

Candidates should be able to:

(a) describe, with the aid of diagrams, the behaviour of chromosomes during meiosis, and the associated behaviour of the nuclear envelope, cell membrane and centrioles. (Names of the main stages are expected, but **not** the subdivisions of prophase.)

(b) explain how meiosis and fertilisation can lead to variation.

(c) explain the terms gene, **allele, locus, phenotype, genotype, dominant, recessive** and **codominant**.

(d) use genetic diagrams to solve problems involving monohybrid and dihybrid crosses, including those involving sex linkage, codominance and multiple alleles. (Solutions of problems involving autosomal linkage and epistasis are **not** expected.)

(e) appreciate the importance of the test cross, and use genetic diagrams to solve problems involving such crosses.

(f) use the chi square test to test the significance of the difference between observed and expected results. (The formula for the chi square test will be provided.) **IT3.2**

(g) explain, with examples, how mutation may affect the phenotype. (Reference should be made to the sickle cell allele as an example of base substitution.)

(h) explain, with examples, how the environment may affect the phenotype.

(i) outline the regulation of protein synthesis in bacteria. (Reference should be made to the *lac* operon in *Escherichia coli* .)

(j) outline the implications of the Human Genome Project. **IT3.2**

5.4.5 Classification, Selection and Evolution

Recommended Prior Knowledge

Candidates should have a knowledge of

- Biology Foundation, Module 2801, section 5.1.5.

Content

- Features of the five Kingdoms.
- Methods of classifying organisms.
- The concept of the species.
- Populations, variation and evolution.
- Natural and artificial selection.
- Structural and physiological adaptations of organisms to their environment.

Learning Outcomes

Candidates should be able to:

(a) describe the important features of the five Kingdoms.

(b) explain the meaning of the term **species**.

(c) describe the classification of species into taxonomic groups (genus, family, order, class, phylum, kingdom), and appreciate the significance of the various concepts of the species.

(d) explain the relationship between classification and phylogeny.

(e) explain how natural selection may bring about evolution.

(f) explain why variation is important in selection.

(g) explain how all organisms can potentially overproduce.

(h) explain, with examples, how environmental factors can act as stabilising or evolutionary forces of natural selection.

(i) describe the processes which affect allele frequencies in populations. (The Hardy-Weinberg principle is **not** required.)

(j) explain the role of isolating mechanisms in the evolution of new species.

(k) outline, with examples, structural and physiological adaptations of organisms to their environment.

(l) describe **one** example of artificial selection.

5.4.6 Control, Coordination and Homeostasis

C3.3

Recommended Prior knowledge

Candidates should have a knowledge of

- Biology Foundation, Module 2801, sections 5.1.1 and 5.1.4.;
- Transport, Module 2803, Component 01.

Content

- The importance of homeostasis.
- Excretion.
- Control of water and metabolic wastes.
- Nervous and hormonal communication.
- Response to changes in the external environment.
- Regulation of the internal environment.
- Communication and control in flowering plants.
- Plant growth regulators.

Learning Outcomes

Candidates should be able to:

(a) discuss the importance of homeostasis in mammals, and explain the principles of homeostasis in terms of receptors, effectors and negative feedback.

(b) define the term **excretion**, and explain the importance of removing nitrogenous waste products and carbon dioxide from the body.

(c) describe the gross structure of the kidney and the detailed structure of the nephron with the associated blood vessels. (Candidates are expected to be able to interpret the histology of the kidney, as seen in sections using the light microscope.)

(d) explain the functioning of the kidney in the control of water and metabolic wastes, using water potential terminology.

(e) outline the need for communication systems within mammals to respond to changes in the internal and external environment.

(f) outline the role of sensory receptors in mammals in converting different forms of energy into nerve impulses.

(g) describe the structure of a sensory neurone and a motor neurone, and outline their functions in a reflex arc.

(h) describe and explain the transmission of an action potential in a myelinated neurone. (The importance of sodium and potassium ions in the impulse transmission should be emphasised.) **3.3**

(i) explain the importance of the myelin sheath (saltatory conduction) and the refractory period in determining the speed of nerve impulse transmission.

(j) describe the structure of a cholinergic synapse, and explain how it functions. (Reference should be made to the role of calcium ions.) **3.3**

(k) outline the roles of synapses in the nervous system in determining the direction of nerve impulse transmission, and in allowing the interconnection of nerve pathways.

(l) explain what is meant by the term **endocrine gland** .

(m) describe the cellular structure of an islet of Langerhans from the pancreas, and outline the role of the pancreas as an endocrine gland.

(n) explain how the blood glucose concentration is regulated by negative feedback control mechanisms, with reference to insulin and glucagon.

(o) explain the advantages of treating diabetics with human insulin produced by genetic engineering.

(p) outline the need for, and the nature of, communication systems within flowering plants to respond to changes in the internal and external environment.

(q) describe the role of auxins in apical dominance.

(r) describe the role of gibberellins in stem elongation and in the germination of wheat or barley.

(s) describe the role of abscissic acid in leaf fall and in the closure of stomata.

5.5 Module 2805, Component 01: Growth, Development and Reproduction

Preamble

In addition to meeting the aims of the specification as a whole, this component is intended to develop

- an understanding of growth, development and reproduction in a range of organisms;
- an understanding of growth and reproduction in the life cycle of an organism;
- an understanding of methods of investigating and measuring growth;
- an understanding of the role of hormonal control in growth and reproduction.

Assessment Objectives

See section 3. Candidates are expected to apply knowledge, understanding and other skills gained in this component to new situations and/or to solve related problems.

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804.

5.5.1 Growth and Development

N3.2, N3.3.

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.1, 5.4.2, 5.4.3 and 5.4.6.

Content

- Growth is an irreversible increase in mass.
- Measurement of growth.
- Development results in an increase in the complexity of organisms.

Learning Outcomes

Candidates should be able to:

(a) explain how cell division and enlargement lead to growth.

(b) describe the techniques for the measurement of the growth of microorganisms, plants and animals, and appreciate the problems of measurement. **N3.2, N3.3**

(c) measure the growth of a chosen organism. (Dry mass measurement should be included.) **N3.2, N3.3**

(d) distinguish between absolute and relative growth rates. **N3.2, N3.3**

(e) recognise different types of growth curve and explain patterns of growth. **N3.2, N3.3**

(f) explain development as a progressive series of changes, including the specialisation of cells. (Reference should be made to shoot and root apices.)

5.5.2 Asexual Reproduction

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.4, 5.4.5 and 5.4.6.

Content

- The range of asexual reproduction.
- Advantages, disadvantages and evolutionary consequences.
- Artificial propagation.
- Cloning.

Learning Outcomes

Candidates should be able to:

(a) describe the range of asexual reproduction using one example from each of the five kingdoms: Prokaryotae, Protoctista, Fungi, Plantae, Animalia.

(b) assess the natural advantages and disadvantages of asexual reproduction and explain its evolutionary consequences.

(c) describe how knowledge of growth and development has been used commercially to develop methods of artificial propagation.

(d) describe the cloning of plants form tissue culture, and assess the advantages and disadvantages of cloning.

5.5.3 Sexual Reproduction in Flowering Plants

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.1, 5.4.2, 5.4.4, 5.4.5 and 5.4.6.

Content

- Flower structure and pollination.
- Fertilisation.
- Changes after fertilisation leading to the development of the seed and fruit.
- Germination.

Learning Outcomes

Candidates should be able to:

(a) recognise and name parts of a typical simple flower.

(b) describe and explain the structural features of a **named** insect-pollinated and a **named** wind-pollinated plant.

(c) describe the mechanisms and compare the outcomes of self-pollination and cross-pollination.

(d) describe anther structure and pollen formation.

(e) describe ovule development.

(f) describe and explain the significance of double fertilisation in the embryo sac.

(g) describe the structural changes which occur after fertilisation leading to the development of the embryo within the seed, and the ovary into the fruit.

(h) investigate embryo development experimentally by using ovules at different stages of development. (Shepherd's purse or other suitable examples can be used.)

(i) describe seed structure and germination in a **named** dicotyledonous seed.

5.5.4 Sexual Reproduction in Humans

C3.1a

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.1, 5.4.4 and 5.4.6.

Content

- Male and female urinogenital systems.
- Gametogenesis.
- Fertilisation
- Early development.

Learning Outcomes

Candidates should be able to:

(a) identify and name the parts of the male and female urinogenital systems.

(b) describe and interpret photographs and drawings of the ovary and testis, as seen using the light microscope. (Prepared slides from a small mammal may be used.)

(c) describe and explain gametogenesis.

(d) describe the structures of egg and sperm.

(e) explain how gametogenesis is controlled by hormones.

(f) describe and explain the menstrual cycle.

(g) describe the passage of sperm from the testes to the oviduct during sexual intercourse.

(h) state how and where fertilisation occurs.

(i) discuss contraception, *in vitro* fertilisation and abortion from biological and ethical viewpoints. **C3.1a**

(j) describe the structure of the placenta.

(k) describe and explain the roles of the placenta and the transport mechanisms involved in placental transfer.

(l) describe the functions of the amnion.

(m) discuss the effect of the actions of the mother on fetal development.

5.5.5 Control of Growth and Reproduction

Recommended Prior Knowledge

Candidates should have knowledge of

- Central Concepts, Module 2804, sections 5.4.1, 5.4.2 and 5.4.6.

Content

- Genetic and environmental factors involved.
- Roles of plant growth regulators.
- Seed dormancy.
- Roles of hormones in mammals.

Learning Outcomes

Candidates should be able to

(a) explain the factors that control flowering in short-day and long-day plants.

(b) describe the use of plant growth regulators in fruit maturation.

(c) carry out an investigation to identify the major factors affecting germination.

(d) describe the reasons for, and the advantages of, seed dormancy.

(e) explain the interactions of plant growth regulators in the control of seed dormancy.

(f) describe the role of hormones in the menstrual cycle, pregnancy, birth and lactation.

(g) outline the involvement of hormones in pre-menstrual tension, hormone replacement therapy and the menopause.

(h) outline the roles of the hypothalamus and the pituitary gland in human growth and development.

(i) describe the role thyrotrophin releasing hormone (TRH) from the hypothalamus and thyroid stimulating hormone (TSH) from the pituitary gland in the control of thyroxine secretion.

(j) describe the role of the thyroid gland and the functions of thyroxine.

5.6 Module 2805, Component 02: Applications of Genetics

Preamble

In addition to meeting the aims of the specification as a whole, this component is intended to develop

- an understanding of the causes of variation;
- an understanding of the principles and uses of selective breeding;
- an understanding of the importance of genetic diversity;
- an understanding of the ways in which organisms can be modified by genetic engineering;
- an understanding of some aspects of human genetics and an appreciation of their medical, ethical and social implications.

Assessment Objectives

See Section 3. Candidates are expected to apply knowledge, understanding and other skills gained in this component to new situations and/or to solve related problems.

Recommended Prior Knowledge:

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.4 and 5.4.5.

5.6.1 Variation

N3.2

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.5.

Content

- Mutations.
- The effect of genotype and environment on phenotype.
- Interaction between loci.
- Linkage and crossing-over.

Learning Outcomes

Candidates should be able to:

- explain, with examples, what is meant by the terms **gene mutation** and **chromosome mutation.**
- describe the difference between continuous and discontinuous variation.
- explain the basis of continuous and discontinuous variation by reference to the number of genes which control the characteristic.
- recognise that both genotype and environment contribute to phenotypic variation. ($V_P = V_G + V_E$) (**No** calculations of heritability will be expected.)
- describe the interaction between loci (epistasis).
- predict phenotypic ratios in problems involving epistasis.
- explain the meaning of the terms **linkage** and **crossing-over**.
- explain the effect of linkage and crossing-over on the phenotypic ratios from dihybrid crosses.
- use the chi square test to test the significance of differences between observed and expected results. **N3.2**

5.6.2 Selective Breeding

C3.1a

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, section 5.4.5.

Content

- The selection of desirable characteristics by selective breeding.
- Progeny testing.
- Artificial insemination.
- Embryo transplantation.
- Social and ethical implications of these techniques.

Learning Outcomes

Candidates should be able to:

(a) outline the principle of selective breeding and explain why selective breeding is carried out.

(b) explain the importance of heritability in selective breeding programmes.

(c) explain, with practical details, how the process of selective breeding may be carried out in **one named** plant and **one named** animal example.

(d) compare selective breeding with the evolutionary process.

(e) explain the use of progeny testing.

(f) describe the use of, and discuss the advantages and disadvantages of, artificial insemination (AI).

(g) describe the use of, and the techniques used in, embryo transplantation.

(h) discuss the ethical implications of the use of AI, *in vitro* fertilisation and embryo transplantation in animals and their social and ethical implications in humans. **C3.1a**

5.6.3 Genetic Diversity

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.4 and 5.4.5.

Content

- The problems of inbreeding.
- The need to maintain genetic resources.
- The development of resistance.

Learning Outcomes

Candidates should be able to:

(a) describe the harmful effects of inbreeding.

(b) explain the need to maintain a gene bank for possible future use, including conserving wild types and rare breeds as genetic resources.

(c) describe the maintenance and use of seed banks and sperm banks.

(d) describe the cloning of plants from tissue culture.

(e) describe the genetic basis of resistance in prokaryotes and eukaryotes.

(f) explain, with specific examples, how selective breeding is used to produce disease-resistant varieties in plants and animals.

(g) describe the evolution of antibiotic resistance in bacteria and pesticide resistance in insects and discuss the implications of the evolution of such resistance.

5.6.4 Genetic Engineering

WO3.1, WO3.2, WO3.3.

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, section 5.4.4.

Content

- Recombinant DNA.
- The modification of organisms by genetic engineering.
- Ethical implications of genetic engineering.

Learning Outcomes

Candidates should be able to:

(a) outline the use of restriction enzymes in removing sections of the genome.

(b) describe the formation of recombinant DNA.

(c) describe **one** use of genetic engineering in agriculture.

(d) discuss the benefits and hazards of genetic engineering, with reference to specific examples. **WO3 (all)**

(e) discuss the ethical implications of genetic engineering.

5.6.5 Human Genetics

C3.1a

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, section 5.4.4.

Content

- Genetic disorders in humans.
- Genetic screening and genetic counselling.
- Gene therapy and its possible benefits and hazards.
- Genetic fingerprinting and its uses.
- The significance of genetic constitution for tissue compatibility in transplant surgery.

Learning Outcomes

(a) describe cystic fibrosis, Huntington's disease and Down's syndrome in humans, and explain how they are inherited. (Issues related to these genetic conditions may need to be handled with sensitivity.)

(b) describe how genetic screening is carried out and appreciate the advantages and disadvantages of genetic screening and the need for genetic counselling. **C3.1a**

(c) explain the theoretical basis of gene therapy and appreciate its possible benefits and hazards.

(d) explain the theoretical basis of genetic fingerprinting and outline how it is carried out.

(e) explain the significance of genetic compatibility in transplant surgery, with reference to ABO blood groups and the major histocompatibility (HLA) system.

5.7 Module 2805, Component 03: Environmental Biology

Preamble

In addition to meeting the aims of the specification as a whole, this component is intended to develop

- an understanding of ecology and the complex interactions occurring in an ecosystem;
- an awareness of the importance of practical investigation into the ecology of plant and animal communities;
- an understanding of some of the causes of pollution;
- an understanding of the impact of agriculture on the environment;
- an understanding of how resources need to be conserved;
- an understanding of conservation issues at the national level.

Assessment Objectives

See section 3. Candidates are expected to apply knowledge, understanding and other skills gained in this component to new situations and/or to solve related problems.

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.1, 5.4.2, 5.4.3 and 5.4.5.

5.7.1 Ecological Fieldwork

N3.1, N3.2, N3.3; IT3.2.

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.2, 5.4.3 and 5.4.5.

Content

- Measurement of abiotic factors in the environment.
- Measurement of animal and plant populations.
- Use of elementary statistical analysis.

Learning Outcomes

Candidates should be able to:

(a) evaluate the use in different habitats of the following techniques: quadrats, point quadrats and belt transects. **IT3.2, N 3.3**

(b) use kite diagrams to show abundance and distribution of organisms in a belt transect.

(c) measure the following abiotic factors in a habitat; temperature, pH, light intensity and, where appropriate, oxygen and moisture content. (The use of datalogging techniques should be attempted where possible, and the use of sensors and computer technology should be encouraged.) **IT3.2, N 3.3**

(d) describe the properties of soil in relation to plant growth, and carry out a soil structure analysis.

(e) assess the size of a mobile animal population using the capture-recapture technique. (The assumptions made in the use of this technique should be appreciated.)

(f) measure and calculate species frequency, species richness and percentage cover. **IT3.2, N3 (all)**

(g) use standard deviation, the chi square test and the t-test and assign appropriate confidence levels to experimental results.

5.7.2 Pollution

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.1, 5.4.2, 5.4.3 and 5.4.5.

Content

- Water pollution.
- Air pollution.
- Use of indicator species.
- Chlorofluorocarbons (CFCs) and the ozone layer.

Learning Outcomes

Candidates should be able to:

(a) describe the causes and effects of eutrophication.

(b) describe the sampling of water and assessment of biological oxygen demand (BOD), and explain how the technique can be used to monitor water quality.

(c) appreciate the need for pesticides and explain the consequences of pollution by DDT.

(d) outline the sources of polychlorinated biphenyls (PCBs) and heavy metals and the consequences of their release on the environment.

(e) explain the production of acid rain and its effects on forest and lakes.

(f) outline the roles of carbon dioxide and methane in the enhanced greenhouse effect and global warming.

(g) appreciate international efforts to reduce carbon dioxide emissions.

(h) define the term **indicator species** and describe how such species can be used to assess practically the levels of **either** air **or** water pollution in a given area.

(i) outline how chlorofluorocarbons (CFCs) damage the ozone layer and the problems which result.

(j) summarise the international agreement reached on the production of CFCs.

5.7.3 Agriculture and the Environment

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.2, 5.4.3 and 5.4.5.

Content

- The biosocial implications of intensive food production.
- Organic farming.
- Biological pest control.

Learning Outcomes

Candidates should be able to:

(a) distinguish between intensive and extensive food production.

(b) explain the effects of burning and grazing in the maintenance of a **deflected succession**.

(c) appreciate the implications of intensive food production in terms of the effect of farm waste on the environment, land reclamation and the destruction of hedgerows.

(d) assess the advantages and disadvantages of organic farming without the use of artificial fertilisers and pesticides in developed countries.

(e) explain the principles, and assess the advantages and disadvantages, of biological pest control.

(f) assess the practice of intercropping, and the use of legumes in crop rotation, as methods of cultivating crops in developing countries.

5.7.4 Conservation of Resources

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.2, 5.4.3 and 5.4.5.

Content

- The meaning of conservation.
- Fisheries.
- Land reclamation.
- Recycling.

Learning Outcomes

Candidates should be able to:

(a) distinguish between the terms **conservation** and **preservation**.

(b) explain that conservation is a dynamic process involving management and reclamation.

(c) appreciate the economic and ethical reasons for conservation of resources.

(d) explain the need for conservation of fish populations in marine ecosystems.

(e) outline the ways in which fish stocks are being conserved in a marine ecosystem, such as the North Sea.

(f) describe how land rendered derelict by industrial activity may be reclaimed for use. (Reference should be made to coal waste and china clay.)

(g) explain the biological principles in the treatment of water for drinking.

(h) explain why it is important to recycle useful commodities, such as paper, glass and plastic bottles.

5.7.5 Conservation Issues

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.3 and 5.4.5.

Content

- National conservation issues.
- International conservation issues.

Learning Outcomes

Candidates should be able to:

(a) discuss the economic and ethical reasons for maintaining biodiversity.

(b) explain how ecologically important areas are protected, with reference to National Parks, Sites of Special Scientific Interest (SSSIs) and Environmentally Sensitive Areas (ESAs).

(c) explain the role of the Royal Society for the Protection of Birds (RSPB) in protecting ecologically important areas in the country.

(d) describe the major conservation issues facing the management of a National Park.

(e) discuss the role of zoos and botanic gardens with regard to captive breeding and release programmes and the preservation of seed banks.

(f) discuss The Convention in International Trade in Endangered Species (CITES) and the problems in its implementation.

(g) discuss the conservation of the African elephant with regard to population numbers, reasons for concern, measures introduced and international co-operation required.

(h) discuss the conservation of tropical rain forest with regard to ecological importance, reasons for decline and international measures that need to be, or are being, taken.

5.8 Module 2805, Component 04: Microbiology and Biotechnology

Preamble

In addition to meeting the aims of the specification as a whole, this component is intended to develop

- an understanding of the nature of microorganisms;
- an appreciation of the need for safe working practices and specialised laboratory techniques for the preparation, growth, monitoring and control of microorganisms;
- an understanding that biotechnology has a wide range of applications, and is a rapidly expanding branch of Biology;
- an appreciation of the economic, social and ethical issues which are raised by applications of biotechnology.

Assessment Objectives

See section 3. Candidates are expected to apply knowledge, understanding and other skills gained in this component to new situations and/or to solve related problems.

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804.

5.8.1 Microbiology

Recommended Prior Knowledge

Candidates should have knowledge of

- Central Concepts, Module 2804, sections 5.4.1, 5.4.2, 5.4.3 and 5.4.4.

Content

- Features of Viruses, Prokayotae, Protoctista and Fungi.
- Structure and life cycle of a bacteriophage and a retrovirus.
- Structure and asexual reproduction of Escherichia coli.
- Gram staining as a method of the primary identification of bacteria.

Learning Outcomes

Candidates should be able to:

(a) describe the distinguishing features of Viruses, Prokaryotae, Protoctista and Fungi.

(b) describe the general structure of viruses.

(c) describe the life cycles of the lysogenic bacteriophage, λ, and the Human Immunodeficiency Virus (HIV).

(d) describe the organisation of the genetic material inside bacterial cells and viruses.

(e) describe the structure and asexual reproduction of Escherichia coli.

(f) describe the differences in bacterial cell wall structure that are the basis of the Gram staining technique.

5.8.2 Techniques used in Microbiology and Cell Culture

N3.3

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.1, 5.4.2, 5.4.3 and 5.4.4.

Content

- Scientific and economic reasons for culturing microorganisms and plant cells
- *In vitro* growth requirements of bacteria, fungi and plant cells.
- Techniques used for the preparation and growth of microorganisms and plant cells.
- Aseptic techniques.
- Specialist laboratory requirements.

Learning Outcomes

Candidates should be able to:

(a) outline the technique of plant tissue culture and explain its importance.

(b) describe the *in vitro* growth requirements of bacteria, fungi and plant cells with reference to carbon and nitrogen sources, mineral nutrients, temperature, pH and aeration. **N3.3**

(c) explain the reasons for safe working practices and the need for risk assessments to be made when using microorganisms.

(d) prepare a nutrient broth and pour nutrient agar plates.

(e) use aseptic (sterile) techniques to inoculate solid and liquid media. (Reference should be made to the use of innoculating loops, spreaders and to the stab technique.)

(f) measure bacterial population growth by means of dilution plating and turbidimetry, and use a haemocytometer. (A comparison of the techniques and the distinction between viable and total cell counts is expected.) **N3.3**

(g) describe the specialist structural features of laboratories working with microorganisms, which are designed to prevent contamination of workers and the environment. (Reference should be made to the use of negative pressure and air flow hoods.)

5.8.3 Large-scale Production

Recommended Prior Knowledge

Candidates should have a knowledge of:

- Central Concepts, Module 2804, sections 5.4.1, 5.4.2, 5.4.3 and 5.4.4.

Content

- Batch and continuous culture of microorganisms.
- Large-scale production methods.
- Problems associated with large-scale production.

Learning Outcomes

Candidates should be able to:

(a) explain what is meant by the terms **batch culture** and **continuous culture**, and compare their advantages and disadvantages with reference to the production of penicillin and mycoprotein.

(b) describe the general structural features of a fermenter used for large-scale production.

(c) explain the major problems associated with large-scale fermentation processes, as opposed to laboratory production. (Reference should be made to the production of penicillin.)

(d) carry out experiments to show the effects of varying conditions on the growth of microorganisms. (Simulation software may be used if fermentation equipment is not available.)

5.8.4 Biotechnology in Food Production

C3.1b, C3.2.

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.1, 5.4.3, 5.4.4 and 5.4.5.

Content

- The production of novel genomes.
- The use of microorganisms and enzymes in food production.
- Microorganisms as a food source.
- Social, economic, ethical and environmental implications.

Learning Outcomes

Candidates should be able to:

(a) describe the production of novel genomes by the isolation of a gene from an organism, followed by its insertion into a new host organism. (Reference should be made to the genetic improvement of crop plants.)

(b) describe and explain the role of biotechnology in the production of cheese, beer, yoghurt and tenderised meat.

(c) describe the use of microorganisms as a food source, with reference to the production of mycoprotein and yeast extract.

(d) appreciate the potential social, economic, ethical and environmental implications of biotechnology and gene manipulation in (a), (b) and (c) above. **C3.1b, C3.2**

5.8.5 Biotechnology in Medicine

C3.1b

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.1, 5.4.2, 5.4.4 and 5.4.5.

Content

- The use of biosensors.
- Monoclonal antibodies and their applications.
- Proteins of medical importance.
- The benefits and hazards of genetic engineering.

Learning Outcomes

Candidates should be able to:

(a) explain what is meant by the term **biosensor**, with reference to the monitoring of blood glucose.

(b) outline **one** method for the production of a monoclonal antibody.

(c) describe the use of monoclonal antibodies in pregnancy testing.

(d) explain the reasons for using microorganisms in processes designed for the large-scale production of insulin and human growth hormone.

(e) describe the detailed sequence of steps that can be used to produce a protein of medical importance, such as human growth hormone.

(f) discuss the benefits and hazards of genetic engineering with reference to suitable examples. **C3.1b**

5.8.6 Biotechnology in Industry and Public Health

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.1, 5.4.2, 5.4.4 and 5.4.5.

Content

- Immobilised enzymes and their use in industry.
- Biogas and gasohol.
- The treatment of domestic and industrial waste.

Learning Outcomes

Candidates should be able to:

(a) explain the technique of enzyme immobilisation.

(b) explain the advantages of enzyme immobilisation in manufacturing industries.

(c) carry out an experiment to demonstrate the use of immobilised enzymes, such as amylase immobilised in alginate.

(d) describe the use of **named** microorganisms and substrates in the production of biogas and gasohol.

(e) describe the use of microorganisms for the treatment of domestic and industrial wastes.

5.9 Module 2805, Component 05: Mammalian Physiology and Behaviour

Preamble

In addition to meeting the aims of the specification as a whole, this component is intended to develop

- an understanding of the principles of heterotrophic nutrition, and the processes of digestion and absorption;
- an understanding of the central role of the liver in metabolism;
- an understanding of the locomotory system and the effects of ageing;
- an understanding of the organisation of the nervous system, and the effects of malfunction;
- an understanding of the structure and functions of the eye and ear as sense organs;
- an understanding of the principles of behaviour.

Assessment Objectives

See section 3. Candidates are expected to apply knowledge, understanding and other skills gained in this component to new situations and/or to solve related problems.

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.1, 5.4.2, 5.4.4 and 5.4.6.

5.9.1 Mammalian Nutrition

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.1 and 5.4.6.

Content

- Principles of heterotrophic nutrition.
- Structure of the human gut and associated organs.
- Digestion and absorption.
- Nervous and hormonal control of digestion.

Learning Outcomes

Candidates should be able to:

(a) explain what is meant by **heterotrophic nutrition**, and outline the basic principles.

(b) explain what is meant by the terms **ingestion**, **digestion**, **absorption** and **egestion**.

(c) distinguish between mechanical and chemical digestion.

(d) recognise on photographs and diagrams, and by using the light microscope, the following main regions of the gut: stomach, ileum and colon.

(e) describe the structure of the stomach and its functions in digestion and absorption.

(f) describe the structure of the ileum and its functions in digestion and absorption.

(g) describe the functions of the colon in absorption.

(h) describe the gross structure and histology of the pancreas and explain its functions as an exocrine gland.

(i) state the site of production and action, and explain the functions of: pepsin, trypsin, chymotrypsin, exopeptidases, amylases, maltase, lipase and bile salts.

(j) describe the specialisation of teeth and digestive systems in a **named** ruminant and a **named** carnivore.

(k) outline the role of the nervous system and hormones in the control of digestion.

5.9.2 The Liver

Recommended Prior Knowledge

Candidates should have knowledge of

- Central Concepts, Module 2804, sections 5.4.1 and 5.4.6.

Content

- Gross structure and histology.
- Roles in metabolism.
- Metabolism of alcohol and the long-term consequences of excessive consumption.

Learning Outcomes

Candidates should be able to:

(a) describe the gross structure of the liver, including its associated blood vessels.

(b) describe the histology of the liver and recognise this using the light microscope.

(c) explain the roles of the liver in carbohydrate metabolism and the production of glucose from amino acids.

(d) explain the roles of the liver in fat metabolism, including the use of fats in respiration, the synthesis of triglycerides from excess carbohydrate and protein, the synthesis and regulation of cholesterol, and the transport of lipids to and from the liver as lipoproteins. (No biochemical details are required.)

(e) explain the roles of the liver in deamination, transamination and urea formation. (An outline of the ornithine cycle is all that is expected.)

(f) describe the production and use of bile.

(g) describe the production and explain the roles of the plasma proteins fibrinogen, globulins and albumin.

(h) outline the roles of the liver in detoxification.

(i) describe the metabolism of alcohol in the liver and the long term consequences of excessive alcohol consumption.

5.9.3 Support and Locomotion

C3.1a

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, sections 5.4.1 and 5.4.6.

Content

- The skeletal system and movement.
- Histology of bone, cartilage and striated muscle.
- Muscle contraction.
- Effects of ageing.

Learning Outcomes

Candidates should be able to:

(a) identify the major limb bones of a mammal. (Reference should be made to the structure of the pentadactyl limb.)

(b) relate the structure of a thoracic and a lumbar vertebra to their functions.

(c) describe the lever action of the human arm. (The importance of antagonistic muscles in movement should be appreciated.)

(d) use the light microscope to interpret the structure of compact bone, and hyaline cartilage.

(e) describe the structure of a synovial joint and identify the different types of joint.

(f) describe the histology and ultrastructure of striated muscle.

(g) describe the structure of a neuromuscular junction and explain how a nerve impulse causes muscle to contract.

(h) describe the sliding filament theory of muscle contraction. (The roles of the control proteins troponin and tropomyosin should be considered.)

(i) outline the effects of ageing on the locomotory system with reference to osteoarthritis and osteoporosis. **C3.1a**

5.9.4 The Nervous System

C3.1a

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, section 5.4.6.

Content

- Organisation of the mammalian nervous system.
- Roles of the autonomic nervous system.
- Brain structure and function
- Alzheimer's disease as an example of brain malfunction.

Learning Outcomes

Candidates should be able to:

(a) describe the organisation of the nervous system with reference to the central and the peripheral systems.

(b) outline the organisation of the autonomic nervous system into a sympathetic and a parasympathetic system.

(c) outline the roles of the autonomic nervous system in controlling the digestive system, heart action and the size of the pupil in the eye.

(d) describe the gross structure of the mammalian brain.

(e) outline the functions of the cerebrum, hypothalamus, cerebellum and medulla oblongata.

(f) describe the symptoms and possible causes of Alzheimer's disease as an example of brain malfunction. **C3.1a**

5.9.5 Sense Organs and the Reception of Stimuli

C3.1a

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, section 5.4.6.

Content

- Structure and functions of the eye.
- Effects of ageing on the eye.
- Structure and functions of the ear.

Learning Outcomes

Candidates should be able to:

(a) describe the gross structure of the eye and outline the functions of its parts, including accommodation.

(b) describe the structure of the retina with reference to the arrangement of rods, cones, bipolar cells and ganglion cells.

(c) relate the structure of the eye to visual acuity, colour vision and sensitivity to different light intensities.

(d) outline the general principles involved in the reception and recognition of visual stimuli by the brain.

(e) discuss the effects of ageing on the eye, with reference to cataracts and their treatment. **C3.1a**

(f) describe the gross structure of the ear and outline the functions of its parts in hearing and balance.

5.9.6 Behaviour

C3.3.

Recommended Prior Knowledge

Candidates should have a knowledge of

- Central Concepts, Module 2804, section 5.4.6.

Content

- Innate behaviour in mammals.
- Learned behaviour.

Learning Outcomes

Candidates should be able to:

(a) explain, with reference to their biological significance, what is meant by innate behaviour, instinct and reflex action.

(b) describe one example of a reflex action.

(c) explain that some behaviour can be interpreted in terms of stereotyped, automatic responses, and that these can be modified by environmental stimuli.

(d) outline the methods and conclusions of the classic experiments to investigate the nature of learned behaviour, with reference to the work of Pavlov on conditioning, the work of Skinner on operant conditioning and the work of Kohler on intelligent behaviour in chimpanzees. **C3.3**

5.10 Module 2806, Component 01: Unifying Concepts in Biology

Preamble

The aims of this component are to give candidates the opportunity

- to demonstrate a knowledge and understanding of facts, principles and concepts studied in the AS specification and in Module 2804 in A2;
- to make connections between different areas of biology.

Assessment Objectives

See Section 3. Candidates are expected 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. They are also be expected to use skills of analysis and interpretation in contexts which may be unfamiliar.

Content

There is no content beyond that given in Modules 2801, 2802 and 2803 Component 01 of the AS specification and Module 2804 in A2. Questions in the paper are based on major themes in biology that run through these modules. The questions may be set on the following areas of the specification which are identified by the reference numbers for each section.

(a) Cell structure and function, 5.1.1.

(b) The structure of specialised cells and the relationship between structure and function at the cellular level, 5.1.1, 5.2.3, 5.3.1, 5.3.3, 5.4.6.

(c) The functions of carbohydrates, proteins and lipids in living organisms, 5.1.2, 5.4.1.

(d) Anabolic reactions, such as protein synthesis and those involved in photosynthesis, 5.1.3, 5.1.5, 5.4.2.

(e) Catabolic reactions, such as decarboxylation in respiration, 5.1.3, 5.4.1.

(f) The importance of water to living organisms, 5.1.2, 5.3.3.

(g) The central role of DNA, 5.1.5, 5.4.4.

(h) The role of mitosis in growth, repair and asexual reproduction, 5.1.6.

(i) The role of meiosis and fertilisation in life cycles and in generating variation, 5.1.6, 5.4.4.

(j) Monohybrid and dihybrid inheritance, 5.4.4.

(k) Energy relationships including respiration, photosynthesis and energy flow through food chains and food webs, 5.1.7, 5.4.1, 5.4.2.

(l) Population growth and the factors that limit the maximum size of populations, 5.4.3.

(m) Changes in ecosystems, with reference to succession, 5.4.3.

(n) The nitrogen cycle, 5.1.7.

(o) Transport across membranes and exchange surfaces in organisms, such as lungs and root hairs, 5.1.4, 5.2.3, 5.3.1, 5.4.6.

(p) Transport mechanisms in mammals and flowering plants, 5.3.1, 5.3.2, 5.3.3.

(q) Physiological and structural adaptations of organisms to their environment, 5.3.1, 5.3.3, 5.4.6.

(r) Selection and evolution, 5.4.5.

(s) The importance of homeostasis in living organisms, 5.4.6.

(t) The role of negative feedback in homeostasis. 5.4.6.

(u) Coordination by the nervous and endocrine system in mammals, 5.4.6.

(v) The physiology and biochemistry of exercise, 5.2.3, 5.3.1, 5.3.2, 5.4.1.

(w) The role of plant growth regulators in coordination and control, 5.4.6.

(x) The factors involved in the incidence and spread of disease, 5.2.1, 5.2.4, 5.2.5, 5.4.4.

(y) The control and prevention of disease, 5.2.5, 5.2.6.

Examination paper

The examination paper for Module 2806, Component 01 consists of short structured questions with some part questions requiring longer, extended answers. There are a range of questions which may involve candidates

(a) analysing and interpreting data in the form of tables, graphs and other methods of presentation;

(b) reading and interpreting a passage of text;

(c) interpreting photographs, drawings and diagrams;

(d) interpreting and/or completing flow charts;

(e) evaluating hypotheses in the light of given data;

(f) evaluating data and experimental techniques;

(g) performing calculations, such as rates, percentage changes, ratios and means;

(h) interpreting simple statistical information, such as means and medians;

(i) bringing together information, principles and concepts from different areas to present a coherent explanation or description

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6 Further Information and Training for Teachers

To support teachers using these specifications, OCR will make the following materials and services available:

- a full programme of In-Service Training (INSET) meetings;
- specimen question papers and mark schemes;
- past question papers and mark-schemes after each examination session;
- teacher support materials, including a Biology Coursework Guidance Handbook;
- written advice on coursework proposals;
- individual feedback to each Centre on the moderation of coursework.
- a Report on the Examination, compiled by senior examining personnel, after each examination session.

If you would like further information about the specifications, please contact OCR.

7 Reading Lists

Cambridge University Press have been commissioned by OCR to produce new material supporting these specifications.

Module 2801: Biology Foundation

Calladine CR and Drew HR. Understanding DNA, Academic Press, 1992.

Clegg CJ and Mackean DG. Advanced Biology: Principles and Applications, John Murray, 1994.

Jones M and Jones G. Advanced Biology, Cambridge University Press, 1997.

Phillips WD and Chilton TJ. A Level Biology, Oxford University Press, 1989.

Reiss MJ and Chapman JL. Ecology and Conservation, Cambridge Modular Sciences, Cambridge University Press, 1994.

Taylor D and Jones M. Foundation Biology, Cambridge Modular Sciences, Cambridge University Press, 1994.

Module 2802: Human Health and Disease

Ball J. Understanding Disease, CW Daniel Co. Ltd, 1990.

Fosbery R. Human Health and Disease, Cambridge Modular Sciences, Cambridge University Press, 1997.

Fullick A. Human Health and Disease, Heinemann Advanced Science, Heinemann Educational Publishers, 1998.

Gray A. World Health and Disease, Open University Press, 1995.

Staines N, Brostoff J and James K. Introducing Immunology, Mosby, 1993.

Toole G and Toole S. Advanced Human and Social Biology, Stanley Thornes (Publishers) Ltd, 1997.

Walker AF. Human Nutrition, Cambridge University Press, 1990.

Module 2803, Component 01: Transport

Clegg CJ and Mackean DG. Advanced Biology: Principles and Applications, John Murray, 1994.

Jones M. Transport, Regulation and Control, Cambridge Modular Sciences, Cambridge University Press, 1995.

Jones M and Jones G. Advanced Biology, Cambridge University Press, 1997.

Phillips WD and Chilton TJ. A Level Biology, Oxford University Press, 1989.

Module 2804: Central Concepts

Clegg CJ and Mackean DG. Advanced Biology: Principles and Applications, John Murray, 1994.

Jones M and Gregory J. Central Concepts in Biology, Cambridge Modular Sciences, Cambridge University Press, 1996.

Jones M. Transport, Regulation and Control, Cambridge Modular Sciences, Cambridge University Press, 1995.

Jones M and Jones G. Advanced Biology, Cambridge University Press, 1997.

Phillips WD and Chilton TJ. A Level Biology, Oxford University Press, 1989.

Reiss MJ and Chapman JL. Ecology and Conservation, Cambridge Modular Sciences, Cambridge University Press, 1994.

Taylor D and Jones M. Foundation Biology, Cambridge Modular Sciences, Cambridge University Press, 1994.

Module 2805, Component 01: Growth, Development and Reproduction

Clegg CJ and Mackean DG. Advanced Biology: Principles and Applications, John Murray, 1994.

Jones M and Jones G. Advanced Biology, Cambridge University Press, 1997.

Phillips WD and Chilton TJ. A Level Biology, Oxford University Press, 1989.

Taylor D. Growth, Development and Reproduction, Cambridge Modular Sciences, Cambridge University Press, 1996.

Module 2805, Component 02: Application of Genetics

British Medical Association. Human Genetics – choice and responsibility, Oxford University Press, 1998.

Burnet L. Essential Genetics – a course book, Cambridge University Press, 1986.

Burnet L. Exercises in Applied Genetics, Cambridge University Press, 1988.

Gregory J. Applications of Genetics, Cambridge Modular Sciences, Cambridge University Press, 1996.

Hayward G. Applied Genetics, University of Bath/Macmillan Science 16–19 Project, Macmillan Education, 1990.

Module 2805, Component 03: Environmental Biology

Allen D. Food, Farming and Environment, Collins Educational,1996.

Alma PJ. Environmental Concerns, Cambridge University Press, 1993.

Cadogan A and Best G. Environment and Ecology, Biology Advanced Studies, Nelson Blackie,1992.

Reiss MJ and Chapman JL. Ecology and Conservation, Cambridge Modular Sciences, Cambridge University Press, 1994.

Tomkins S (ed). Biology at Work, Cambridge University Press, 1992.

Module 2805, Component 04: Microbiology and Biotechnology

Cadogan A and Hanks J. Microbiology and Biotechnology, Nelson,1995.

Hayward G. Applied Genetics, University of Bath/Macmillan Science 16–19 Project, Macmillan Education, 1990.

Lowrie P and Wells S. Microbiology and Biotechnology, Cambridge Modular Sciences, Cambridge University Press, 1996.

Tomkins S (ed). Biology at Work, Cambridge University Press, 1992.

Module 2805, Component 05: Mammalian Physiology and Behaviour

Clegg CJ and Mackean DG. Advanced Biology: Principles and Applications, John Murray, 1994.

Green N, Stout W and Taylor D. Biological Science 1 and 2, Cambridge University Press, 1994

Jones M and Jones G. Advanced Biology, Cambridge University Press, 1997.

McNeill Alexander R. The Human Machine, British Museum (Natural History) Publications, 1992.

Phillips WD and Chilton TJ. A Level Biology, Oxford University Press, 1989.

Reiss MJ and Sants H. Behaviour and Social Organisations, Cambridge University Press, 1987.

Appendix A

Key Skills

These specifications provide opportunities for the development of the Key *Skills of Communication, Application of Number, Information Technology, Working With Others, Improving Own Learning and Performance* and *Problem Solving* as required by QCA's subject criteria for Biology.

Through classwork, coursework and preparation for external assessment, candidates may produce evidence for Key Skills at Level 3. However, the extent to which this evidence fulfils the requirements of the QCA Key Skills specifications at this level will be dependent on the style of teaching and learning adopted for each module. In some cases, the work produced may meet the evidence requirements of the Key Skills specifications at a higher or lower level.

Throughout section 5 the symbol  is used in the margin to highlight where Key Skills development opportunities are signposted. The following abbreviations are used to represent the above Key Skills:

C= Communication

N= Application of Number

IT= Information Technology

WO= Working with Others

LP= Improving Own Learning and Performance

PS= Problem Solving

These abbreviations are taken from the Key Skills specifications for use in programmes starting from September 2000. References in section 5 and Appendix A, for example **IT3.1**, show the Key Skill (IT), the level (3) and subsection (1).

Centres are encouraged to consider the OCR Key Skills scheme to provide certification of Key Skills for their candidates.

Detailed opportunities for generating Key Skills evidence through this specification are posted on the OCR website, www.ocr.org.uk

Key Skills Coverage

For each module, the following matrix indicates those Key Skills for which opportunities for at least some coverage of the relevant Key Skills unit exist.

Module	Communication	Application of Number	IT	Working with others	Learning Performance	Problem Solving
	Level 3	Level 3	Level 3	Level 3	Level 3	Level 3
2801	✓	✓	✓	✓	✓	✓
2802	✓		✓	✓	✓	✓
2803	✓	✓	✓			✓
2804	✓	✓	✓		✓	✓
2805	✓	✓	✓	✓		
2806	✓	✓	✓			✓

Appendix B

Notes for Guidance on Coursework Assessment and Submission

This Appendix is intended to provide guidance for teachers in assessing experimental and investigative skills, but should not exert an undue influence on the methods of teaching or provide a constraint on the practical work undertaken by candidates. It is not expected that all of the practical work undertaken by candidates would be appropriate for assessment.

For examples of suitable tasks for assessing practical skills, and for examples of possible individual studies, teachers should refer to the AS/A Biology Teacher Support: Coursework Guidance Handbook. Copies can be ordered from the OCR Publications Department.

The experimental and investigative skills to be assessed are:

P - Planning;

I - Implementing;

A - Analysing Evidence and Drawing Conclusions;

E - Evaluating Evidence and Procedures.

It is expected that candidates will have had opportunities to acquire experience and develop the relevant skills before assessment takes place.

The skills may be assessed at any time during the course using suitable practical activities, based on laboratory or field work, related to or part of the content of the teaching course. The context(s) for the assessment of the coursework for Unit 2803, Component 02 should be drawn from the content of AS Modules 2801, 2802 and 2803, Component 01; the context(s) for the assessment of the coursework for Unit 2806, Component 02 should be drawn from the content of A2 Modules 2804, 2805 and 2806, Component 01 in which the level of demand of the related scientific knowledge and understanding is higher.

In AS and in A2, the skills may be assessed in the context of separate practical exercises, although more than one skill may be assessed in any one exercise. The skills may also be assessed all together in the context of a single 'whole investigation' in which the task is set by the teacher, or by using individual investigations in which each candidate pursues his or her own choice of assignment.

Skills **P** and **A** are marked out of 8 and Skills **I** and **E** are marked out of 7. Thus, for each candidate entered for Unit 2803, Component 2, and for Unit 2806, Component 2, Centres are required to award **one** mark for each of Skills **P**, **I**, **A** and **E**. Hence the maximum raw mark available for each of AS and A2 is 30. These marks are then doubled so that the final marks submitted are out of **60**.

When a skill has been assessed on more than one occasion, in AS or in A2, the better or best mark for that skill should be submitted. However, Centres are recommended not to assess the skills on more than two occasions in each of AS and A2 since this may take up time which might better be devoted to other aspects of the specifications. In each of AS and A2, the time required for the internal assessment of experimental and investigative work is normally expected to be between 5 and 10 hours.

All coursework is marked by the teacher and internally standardised by the Centre. Marks are then submitted to OCR by a specified date, after which postal moderation takes place in accordance with OCR procedures. The purpose of moderation is to ensure that the standard for the award of marks in coursework is the same for each Centre, and that each teacher has applied the standards appropriately across the range of candidates within the Centre.

The Demand of an Activity

The demand of an activity is an important feature of the assessment. From the bottom to the top of the mark range in a skill area the activity should involve increasing demands of associated scientific knowledge and understanding, manipulation, precision and accuracy and complexity.

The difference in standard of AS and A2 is a product of the level of demand of the related scientific knowledge and understanding, together with the complexity and level of demand of the tasks set. Also the mark descriptors for Skills **P** and **A** at A2 include synoptic assessment.

In A2, candidates are required to apply knowledge, understanding and skills from the AS and A2 parts of the specification in planning experimental work and in the evaluation of data (synoptic assessment). Details of the way in which tasks can be differentiated are given in Section 4.2 and further guidance on setting appropriate tasks is given in guidance material published separately.

Teachers should appreciate that the choice of an activity that is comparatively undemanding (primarily in terms of the level of the scientific knowledge and understanding that can be linked to the activity, and in the range/complexity of the equipment/techniques used) may prevent access to the highest marks.

Teachers should be aware of this feature of the assessment so that, when considering the award of higher marks, the activity should require a sophisticated approach and/or complex treatment. Higher marks must not be awarded for work that is simplistic or trivial.

One of the factors that determine the demand of an activity is the level of guidance given to candidates. The use of a highly structured worksheet, for example, will reduce the number of decisions and judgements required by the candidate and so will limit the range of marks available.

Marking Candidates' Work

A similar set of mark descriptors is used for AS and A2 (see Appendix C). The descriptors should be used to make a judgement as to which mark best fits a candidate's performance.

The descriptors have been written to provide clear continuity from the assessment of Sc1 for GCSE. This should ensure an effective continuation of the development of candidates' skills from GCSE to AS and Advanced GCE.

The mark descriptors within a skill area have been written to be hierarchical. Thus, in marking a piece of work, the descriptors for the lowest defined mark level should be considered first and only if there is a good match should the descriptors for the next level up be considered. Therefore, if a teacher is considering awarding a high mark for a piece of work, the work must have demonstrated a good match to all the lower mark descriptors.

For each skill, the scheme allows the award of intermediate marks (between the defined mark levels). An intermediate mark may be awarded when the work of a candidate exceeds the requirements of a defined mark level but does not meet the requirements of the next higher defined mark level sufficiently to justify its award. Thus, an intermediate mark could be awarded if the work meets only one of the two descriptors at the higher defined mark level, or provides a partial match to both descriptors, or provides a complete match to one and a partial match to the other.

In skills **P** and **A**, a mark above the highest defined mark level should be awarded for work which meets all the requirements of the descriptors for the highest defined mark level, and is judged to be of exceptional merit in terms of originality, depth, flair, or in the use of novel or innovative methods.

A mark of zero should be awarded where there has been an attempt to address the skill but the work does not meet the requirements of the lowest defined mark level.

The marks awarded should be based on both the final written work and on the teacher's knowledge of the work carried out by the candidate. In assigning a mark, attention should be paid to the extent of any guidance needed by, or given to, the candidate.

In defining the various mark descriptors it is recognised that practical tasks vary widely, both in the experimental procedures used, and in the nature of the observations and measurements which may be made by the candidate. The mark descriptors for each defined level are intended to provide guidance to teachers on how to recognise levels of achievement. It is acknowledged that the balance between the statements provided for a particular level of performance will vary with the nature of the activity. Whilst both statements for a particular defined level must be considered in awarding the marks, it is clear that teachers will need to judge for themselves the relative weightings they attach to each of the statements.

Synoptic Assessment

Synoptic assessment involves the explicit drawing together of knowledge, understanding and skills learned in different parts of the Advanced GCE course. Assessment Objective AO4 relates specifically to synoptic assessment and marks from Unit 2806, Component 02, Experimental Skills 2, contribute to the assessment of AO4.

During experimental and investigative work, synoptic assessment

- allows candidates to apply knowledge and understanding of principles and concepts from different parts of the specification in planning experimental work and in the analysis and evaluation of data;
- allows candidates to apply skills and techniques learned during the course.

All practical work assessed internally by Centres for the A2 Unit 2806, Component 02 should draw on the range of experience that the candidate has acquired during the AS and A2 courses. It is particularly important that an exercise used to assess planning skills should involve an element of research which goes beyond the repetition of an experiment that simply reflects the use of ideas or techniques met within the module currently being studied. Likewise, an assessment involving analysing evidence and drawing conclusions must require a candidate to use knowledge and understanding acquired outside the confines of a standard experiment recently practised. During the process of moderation, evidence will be sought that such breadth has been achieved.

The assessment descriptors for the skills of Planning (**P**) and Analysing Evidence and Drawing Conclusions (**A**), include statements that relate specifically to synoptic assessment. **These are shown in bold and should be applied only when assessing A2 work.** Thus, in A2, a candidate will not be able to achieve more than 2 marks in each of Skills **P** and **A** without demonstrating aspects of synoptic assessment. Candidates will also bring to the assessment of Skill **I** (Implementing) their experience of practical and investigative work from throughout the course. In Skill **E** (Evaluating Evidence and Procedures), aspects of Skills **P** and **A** are evaluated. Overall, in A2, approximately 15 of the 30 available marks can thus be identified as contributing to an assessment of AO4 (synoptic assessment).

Quality of Written Communication

Coursework must include an assessment of candidates' quality of written communication. At Level 3, candidates are required to:

- select and use a form and style of writing that is appropriate to the purpose and complex subject matter;
- organise relevant information clearly and coherently, using specialist vocabulary when appropriate;
- ensure the text is legible and that spelling, grammar and punctuation are accurate, so that the meaning is clear.

The mark descriptors for Skills **P** and **A** have been written to include these aspects, and these skills carry an additional mark each in recognition of this.

Annotation of Candidates' Work

Each piece of assessed coursework must be annotated to show how the marks have been awarded in relation to the relevant skills.

The writing of comments on candidates' work can provide a means of dialogue and feedback between teacher and candidate, and a means of communication between teachers during internal standardisation of coursework. The main purpose of annotating candidates' coursework should be, however, to provide a means of communication between the teacher and the Moderator, showing where marks have been awarded and why. The sample of work which is submitted for moderation **must** show how the marks have been awarded in relation to the marking criteria.

Annotations should be made at appropriate points in the margins of the text. The annotations should indicate both where achievement for a particular skill has been recognised, and where the mark has been awarded. It is suggested that the minimum which is necessary is that the 'shorthand' mark descriptors (for example, **P**.5a, **I**.3b) should be written at the point in the text where it is judged that the work has met the descriptors concerned.

For Skill **I**, Implementing, more detail is necessary and the Moderator will require evidence concerning candidates' use of practical techniques and safe working practice. This evidence could take the form of checklists or written notes.

Health and Safety

In UK law, health and safety is the responsibility of the employer. For most establishments entering candidates for GCE AS and Advanced GCE this is likely to be the education authority or the governing body. Employees, i.e. teachers and lecturers, have a duty to cooperate with their employer on health and safety matters.

Various regulations, but especially the COSHH Regulations 1996 and the Management of Health and Safety at Work Regulations 1992, require that before any activity involving a hazardous procedure or harmful microorganisms is carried out, or hazardous chemicals are used or made, the employer must provide a risk assessment. A useful summary of the requirements for risk assessment in school or college science can be found in Chapter 4 of Safety in Science Education (see below). For members, the CLEAPSS guide, Managing Risk Assessment in Science offers detailed advice.

Most education employers have adopted a range of nationally available publications as the basis for their Model Risk Assessments. Those commonly used include:

Safety in Science Education, DfEE, 1996, HMSO, ISBN 0 11 270915 X;

Safeguards in the School Laboratory, 10th edition, 1996, ASE ISBN 0 86357 250 2;

Hazcards, 1995, CLEAPSS School Science Service*;

Laboratory Handbook, 1988-97, CLEAPSS School Science Service*;

Topics in Safety, 2nd edition, 1988, ASE ISBN 0 86357 104 2;

Safety Reprints, 1996 edition, ASE ISBN 0 86357 246 4.

Hazardous Chemicals, A Manual for Science Education, SSERC Limited 1997, ISBN 0 95317 760 2

* Note that CLEAPSS publications are only available to members or associates.

(Other publications have sometimes been suggested, e.g. the DES Microbiology, an HMI Guide for Schools and FE, but this is now out of print).

Where an employer has adopted these or other publications as the basis of their model risk assessments, an individual school or college then has to review them, to see if there is a need to modify or adapt them in some way to suit the particular conditions of the establishment. Such adaptations might include a reduced scale of working, deciding that the fume cupboard provision was inadequate, or that the skills of the candidates were insufficient to attempt particular activities safely. The significant findings of such risk assessment should then be recorded, for example on schemes of work, published teachers guides, work sheets, etc. There is no specific legal requirement that detailed risk assessment forms should be completed, although a few employers require this.

Where project work or individual investigations, sometimes linked to work-related activities, are included in specifications these may well lead to the use of novel procedures, chemicals or microorganisms, which are not covered by the employer's model risk assessments. The employer should have given guidance on how to proceed in such cases. Often, for members, it will involve contacting the CLEAPSS School Science Service (or, in Scotland, SSERC).

When candidates are planning their own practical activities, whether in project work or for more routine situations, the teacher or lecturer has a duty to check the plans before practical work starts and to monitor the activity as it proceeds

.

Appendix C

Mark Descriptors for Experimental and Investigative Skills

In defining the various mark descriptors, it is recognised that practical tasks vary widely, both in the experimental procedures used and in the nature of the observations and measurements which may be made by the candidate. The mark descriptors within each defined level are intended to provide guidance to teachers on how to recognise levels of achievement.

It is acknowledged that the balance between the statements provided for a particular level of performance will vary with the nature of the activity. Whilst both statements for a particular level must be considered in awarding the marks, it is clear that teachers will need to judge for themselves the relative weightings they attach to each of the statements.

For examples of suitable tasks for assessing practical skills, and for examples of possible individual studies, teachers should refer to AS/A Biology Teacher Support : Coursework Guidance Handbook. Copies can be ordered from the OCR Publications Department.

Skill P – Planning		Total 8
Mark	**Descriptor**	**The candidate:**
1	**P.1a**	develops a question or problem in simple terms and plans a fair test or an appropriate practical procedure, making a prediction where relevant.
	P.1b	chooses appropriate equipment.
2		
3	**P.3a**	develops a question or problem using scientific knowledge and understanding **drawn from more than one area of the specification**; identifies the key factors to vary, control or take account of.
	P.3b	decides on a suitable number and range of observations and/or measurements to be made.
4		
5	**P.5a**	uses detailed scientific knowledge and understanding **drawn from more than one module of the specification** and information from preliminary work or a secondary source to plan an appropriate strategy, taking into account the need for safe working and justifying any prediction made;
	P.5b	describes a strategy, including choice of equipment, which takes into account the need to produce precise and reliable evidence; produces a clear account and uses specialist vocabulary appropriately.
6		
7	**P.7a**	retrieves and evaluates information from a variety of sources, and uses it to develop a strategy which is well structured, logical and linked coherently to underlying scientific knowledge and understanding drawn from different parts of the AS and A2 specification; uses spelling, punctuation and grammar accurately.
	P.7b	justifies the strategy developed, including the choice of equipment, in terms of the need for precision and reliability.
8		

The statements in **bold** represent additional requirements for Unit 2806, Component 02. They are not to be used for Unit 2803, Component 02.

Both statements at a defined level must be satisfied in order that the mark for this level is awarded. All descriptors for lower defined levels must be satisfied before a higher mark is awarded. From the bottom to the top of the mark range the activity should involve increasing demands of related scientific knowledge and understanding, manipulation, precision, accuracy and complexity.

Skill I – Implementing		Total 7
Mark	**Descriptor**	**The candidate:**
1	**I.1a**	demonstrates competence in simple techniques and an awareness of the need for safe working.
	I.1b	makes and records observations and/or measurements which are adequate for the activity.
2		
3	**I.3a**	demonstrates competence in practised techniques and is able to manipulate materials and equipment with precision.
	I.3b	makes systematic and accurate observations and/or measurements which are recorded clearly and accurately.
4		
5	**I.5a**	demonstrates competence and confidence in the use of practical techniques; adopts safe working practices throughout.
	I.5b	makes observations and/or measurements with precision and skill; records observations and/or measurements in an appropriate format.
6		
7	**I.7a**	demonstrates skilful and proficient use of all techniques and equipment.
	I.7b	makes and records all observations and/or measurements in appropriate detail and to the degree of precision permitted by the techniques or apparatus.

Both statements at a defined level must be satisfied in order that the mark for this level is awarded. All descriptors for lower defined levels must be satisfied before a higher mark is awarded. From the bottom to the top of the mark range the activity should involve increasing demands of related scientific knowledge and understanding, manipulation, precision, accuracy and complexity.

Skill A - Analysing Evidence & Drawing Conclusions		Total 8
Mark	**Descriptor**	**The candidate:**
1	**A.1a**	carries out some simple processing of the evidence collected from experimental work.
	A.1b	identifies trends or patterns in the evidence and draws simple conclusions.
2		
3	**A.3a**	processes and presents evidence gathered from experimental work including, where appropriate, the use of appropriate graphical and/or numerical techniques.
	A.3b	links conclusions drawn from processed evidence with the associated scientific knowledge and understanding drawn from more than one area of the specification.
4		
5	**A.5a**	carries out detailed processing of evidence and analysis including, where appropriate, the use of advanced numerical techniques such as statistics, the plotting of intercepts or the calculation of gradients.
	A.5b	draws conclusions which are consistent with the processed evidence and links these with detailed scientific knowledge and understanding drawn from more than one module of the specification; produces a clear account which uses specialist vocabulary appropriately.
6		
7	**A.7a**	where appropriate, uses detailed scientific knowledge and understanding drawn from different parts of the AS and A2 specification to make deductions from the processed evidence, with due regard to nomenclature, terminology and the use of significant figures (where relevant).
	A.7b	draws conclusions which are well structured, appropriate, comprehensive and concise, and which are coherently linked to underlying scientific knowledge and understanding drawn from different parts of the AS and A2 specification; uses spelling, punctuation and grammar accurately.
8		

The statements in **bold** represent additional requirements for Unit 2806, Component 02. They are not to be used for Unit 2803, Component 02.

Both statements at a defined level must be satisfied in order that the mark for this level is awarded. All descriptors for lower defined levels must be satisfied before a higher mark is awarded. From the bottom to the top of the mark range the activity should involve increasing demands of related scientific knowledge and understanding, manipulation, precision, accuracy and complexity.

Skill E - Evaluating Evidence and Procedures		Total 7
Mark	**Descriptor**	**The candidate:**
1	**E.1a**	makes relevant comments on the suitability of the experimental procedures.
	E.1b	recognises any anomalous results.
2		
3	**E.3a**	recognises how limitations in the experimental procedures and/or strategy may result in sources of error.
	E.3b	comments on the accuracy of the observations and/or measurements, suggesting reasons for any anomalous results.
4		
5	**E.5a**	indicates the significant limitations of the experimental procedures and/or strategy and suggests how they could be improved.
	E.5b	comments on the reliability of the evidence and evaluates the main sources of error.
6		
7	**E.7a**	justifies proposed improvements to the experimental procedures and/or strategy in terms of increasing the reliability of the evidence and minimising significant sources of error.
	E.7b	assesses the significance of the uncertainties in the evidence in terms of their effect on the validity of the final conclusions drawn.

Both statements at a defined level must be satisfied in order that the mark for this level is awarded. All descriptors for lower defined levels must be satisfied before a higher mark is awarded. From the bottom to the top of the mark range the activity should involve increasing demands of related scientific knowledge and understanding, manipulation, precision, accuracy and complexity.

Appendix D

Mathematical Requirements

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 $x^2, \frac{1}{x}, \sqrt{x}, \log_{10} x$.

Handling Data

At AS, candidates should be able to:

- use an appropriate number of significant figures;
- find arithmetic means;
- construct and interpret frequency tables and diagrams, bar charts, pie charts and histograms;
- use a technique for smoothing a set of data;
- interpret and use logarithmic scales.

In addition at A2, candidates should be able to:

- have sufficient understanding of probability to understand genetic ratios;
- 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;
- understand the use of scatter plots and correlation coefficients to identify a relationship between two variables;
- use a simple statistical test, such as χ^2 and the *t*-test.

Algebra

Candidates should be able to:

- understand and use the following symbols: <,> $\Delta, \approx, \propto$; .
- understand and use the prefixes: giga (G), mega (M), kilo (k), milli (m), micro ( ), nano (n);
- 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 a rate of change from a graph showing a linear relationship.

Appendix E

Notes for Guidance on Practical Examinations

Introduction

The following notes are intended to give Centres and candidates an indication of the type of practical exercises that may be set in the practical examinations, which test Skills **I**, **A** and **E**. Practical Instructions, containing details of the apparatus and materials to be supplied to the candidates for the examination, will be sent to Centres by a specified date before the examination. Any unusual materials, as well as any prepared microscope slides, will be provided by OCR.

The Practical Test papers normally consist of **two** questions. The first question is an experiment for the candidates to perform, to investigate some aspect of plant or animal physiology. Where more unusual materials are required for the experiment, these will normally be supplied by OCR. Adequate supplies of such material will be sent to the Centre based on entry information. Dissection of animal material will **not** be required.

The second question is based on microscope work and normally involves the use of microscope slides or photographs provided by OCR, although candidates may be required to produce their own temporary mounts of plant material, where appropriate. The number of OCR prepared slides supplied to the Centre will be based on entry information. Prepared microscope slides are supplied on the basis of **one slide shared between two candidates**, on the assumption that the Centre provides a minimum of one microscope to be shared between two candidates. Microscopes should have suitable low power and high power objective lenses (e.g. x10 and x40). The Supervisor of the practical examination is required to direct the candidates at the start of the examination as to which question should be attempted first, given the availability of microscopes.

Apparatus List

The list given below has been drawn up in order to give guidance to Centres concerning the apparatus that is expected to be generally available for examination purposes. The list is not intended to be exhaustive; in particular, items such as Bunsen burners, tripods, glass tubing, that are commonly regarded as standard equipment in a biological laboratory, are not included. Unless otherwise stated, the rate of allocation is ‘per candidate’.

tin as waterbath

stopwatch/stopclock

glassware marker

wash bottle

thermometer -10^{o}C to +110^{o}C

glass rod

bench lamp

pipette filler

white tile

filter funnel

spatula

6 watch glasses

4 Petri dishes with lids

coarse and fine teat pipettes

glass pipette, 10 cm^3, 25 cm^3

measuring cylinders, 25 cm^3, 50 cm^3

glass beakers, 50 cm^3, 100 cm^3, 250 cm^3

6 test-tubes (e.g. 12 x 1.4 cm)

solid rubber bungs to fit test-tubes

6 boiling tubes (e.g. 15 x 2.5 cm)

single-hole rubber bungs to fit boiling tubes

test-tube holder

test-tube rack

6 corked specimen tubes

syringes, 1 cm^3, 5 cm^3, 10 cm^3, 20 cm^3

mounted needle

coarse and fine sharp scalpels

coarse and fine forceps

coarse and fine dissecting scissors

hand lens (x10)

microscope with low power and high power objective lenses (x10 and x40) shared between 2 candidates

balance, single pan, direct reading, 0.01g or better, shared 1 per 8 to 12 candidates

Appendix F
Glossary of Terms used in Question Papers

It is hoped that the glossary will prove helpful to candidates as a guide, although it is not exhaustive. The glossary has been deliberately kept brief not only with respect to the number of terms included but also to the descriptions of their meanings. Candidates should appreciate that the meaning of a term must depend in part on its context. They should also note that the number of marks allocated for any part of a question is a guide to the depth of treatment required for the answer.

(a) *Define* (the term[s])... is intended literally. Only a formal statement or equivalent paraphrase being required.

(b) *Explain / What is meant by (the terms[s]...)* normally implies that a definition should be given, together with some relevant comment on the significance or context of the term(s) concerned, especially where two or more terms are included in the question. The amount of supplementary comment intended should be interpreted in the light of the indicated mark value.

(c) *Explain* may imply reasoning or some reference to theory, depending on the context.

(d) State ... implies a concise answer with little or no supporting argument, for example, a numerical answer that can be obtained by 'inspection'.

(e) *List* ... requires a number of points with no elaboration. Where a given number of points is specified, this should not be exceeded.

(f) *Describe* ... requires candidates to state in words (using diagrams where appropriate) the main points of the topic. It is often used with reference either to particular phenomena or to particular experiments. In the former instance, the term usually implies that the answer should include reference to (visual) observations associated with the phenomena. The amount of description intended should be interpreted in the light of the indicated mark value.

(g) *Discuss* ... requires candidates to give a critical account of the points involved in the topic.

(h) *Outline* implies that only the essential points are required without any supporting detail.

(i) *Comment* is intended as an open-ended instruction, inviting the candidates to recall or infer points of interest relevant to the context of the question, taking account of the number of marks available.

(j) *Deduce / Predict* ... implies that candidates are not expected to produce the required answer by recall but by making a logical connection between other pieces of information. Such information may be wholly given in the question or may depend on answers extracted in an earlier part of the question. Predict also implies a concise answer with no supporting statement required.

(k) *Suggest* ... is used in two main contexts. It may imply either that there is no unique answer, or that candidates are expected to apply their general knowledge to a 'novel' situation, one that formally may not be 'in the specification'.

(l) *Calculate* ... is used when a numerical answer is required. In general, working should be shown.

(m) *Measure* ... implies that the quantity concerned can be directly obtained from a suitable measuring instrument, for example, length using a rule, or angle using a protractor.

(n) *Determine* ... often implies that the quantity concerned cannot be measured directly but is obtained by calculation, substituting measured or known values of other quantities into a standard formula. It may also be used in the context of a procedure that needs to be carried out so that a numerical answer may be obtained. For example, it may be necessary to find the energy absorbed by a plant so that its efficiency may be calculated.

(o) *Show* ... is used when an algebraic deduction has to be made to prove a given equation. It is important that the terms being used by candidates are stated explicitly.

(p) *Estimate* ... implies a reasoned order of magnitude statement or calculation of the quantity concerned. Candidates should make such simplifying assumptions as may be necessary about points of principle and about the values of quantities not otherwise included in the question.

(q) *Sketch* ... when applied to graph work, implies that the shape and/or position of the curve need only be qualitatively correct. However, candidates should be aware that, depending on the context, some quantitative aspects may be looked for, for example, passing through the origin, having an intercept, asymptote or discontinuity at a particular value. On a sketch graph it is essential that candidates clearly indicate what is being plotted on each axis.

(r) *Sketch* ... when applied to diagrams, implies that a simple, freehand drawing is acceptable. Nevertheless, care should be taken over proportions and the clear exposition of important details.