Qualification Accredited

OCR
Oxford Cambridge and RSA

AS LEVEL

Specification

# BIOLOGY B
# (ADVANCING BIOLOGY)

**H022**

For first assessment in 2016

Version 2.4 (February 2024)

ocr.org.uk/alevelbiologyb

*Disclaimer*

Specifications are updated over time. Whilst every effort is made to check all documents, there may be contradictions between published resources and the specification, therefore please use the information on the latest specification at all times. Where changes are made to specifications these will be indicated within the document, there will be a new version number indicated, and a summary of the changes. If you do notice a discrepancy between the specification and a resource please contact us at: resources.feedback@ocr.org.uk

We will inform centres about changes to specifications. We will also publish changes on our website. The latest version of our specifications will always be those on our website (ocr.org.uk) and these may differ from printed versions.



Oxford Cambridge and RSA is a Company Limited by Guarantee. Registered in England. Registered company number 3484466.

*Registered office:*
*The Triangle Building*
*Shaftesbury Road*
*Cambridge*
*CB2 8EA*

*OCR is an exempt charity.*

# Contents

## Introducing…

# AS Level Biology B (Advancing Biology) (from September 2015)

In this specification, learners study biology using a context-based approach. Ideas are introduced within relevant and interesting settings that help learners to anchor their conceptual knowledge of the range of biological topics required at GCE level. Practical skills are embedded within the specification and learners are expected to carry out practical work in preparation for a written examination that will specifically test these skills.

### Contact the team

We have a dedicated team of people working on our AS Level Biology qualifications.

If you need specialist advice, guidance or support, get in touch as follows:

- **01223 553998**
- **scienceGCE@ocr.org.uk**
- **@ocr_science**

Vertical black lines indicate a significant change to the previous printed version.

## Teaching and learning resources

We recognise that the introduction of a new specification can bring challenges for implementation and teaching. Our aim is to help you at every stage and we're working hard to provide a practical package of support in close consultation with teachers and other experts, so we can help you to make the change.

**Designed to support progression for all**

Our resources are designed to provide you with a range of teaching activities and suggestions so you can select the best approach for your particular students. You are the experts on how your students learn and our aim is to support you in the best way we can.

**We want to…**

- Support you with a body of knowledge that grows throughout the lifetime of the specification
- Provide you with a range of suggestions so you can select the best activity, approach or context for your particular students
- Make it easier for you to explore and interact with our resource materials, in particular to develop your own schemes of work
- Create an ongoing conversation so we can develop materials that work for you.

**Plenty of useful resources**

You'll have four main types of subject-specific teaching and learning resources at your fingertips:

- Delivery Guides
- Transition Guides
- Topic Exploration Packs
- Lesson elements.

Along with subject-specific resources, you'll also have access to a selection of generic resources that focus on skills development and professional guidance for teachers.

**Skills Guides** – we've produced a set of Skills Guides that are not specific to Biology, but each covers a topic that could be relevant to a range of qualifications – for example, communication, legislation and research. Download the guides at ocr.org.uk/skillsguides

**Active Results** – a free online results analysis service to help you review the performance of individual students or your whole school. It provides access to detailed results data, enabling more comprehensive analysis of results in order to give you a more accurate measurement of the achievements of your centre and individual students. For more details refer to ocr.org.uk/activeresults

## Professional Development

Take advantage of our improved Professional Development Programme, designed with you in mind. Whether you want to come to face-to-face events, look at our new digital training or search for training materials, you can find what you're looking for all in one place at the CPD Hub.

**An introduction to the new specifications**

We'll be running events to help you get to grips with our AS Level Biology B (Advancing Biology) qualification.

These events are designed to help prepare you for first teaching and to support your delivery at every stage.

Watch out for details at **cpdhub.ocr.org.uk**.

To receive the latest information about the training we'll be offering, please register for AS Level email updates at **ocr.org.uk/updates**.

# 1 Why choose an OCR AS Level in Biology B (Advancing Biology)?

## 1a. Why choose an OCR qualification?

Choose OCR and you've got the reassurance that you're working with one of the UK's leading exam boards. Our new AS Level in Biology B (Advancing Biology) course has been developed in consultation with teachers, employers and higher education to provide students with a qualification that's relevant to them and meets their needs.

We're part of the Cambridge Assessment Group, Europe's largest assessment agency and a department of the University of Cambridge. Cambridge Assessment plays a leading role in developing and delivering assessments throughout the world, operating in over 150 countries.

We work with a range of education providers, including schools, colleges, workplaces and other institutions in both the public and private sectors. Over 13,000 centres choose our A levels, GCSEs and vocational qualifications including Cambridge Nationals and Cambridge Technicals.

**Our Specifications**

We believe in developing specifications that help you bring the subject to life and inspire your students to achieve more.

We've created teacher-friendly specifications based on extensive research and engagement with the teaching community. They're designed to be straightforward and accessible so that you can tailor the delivery of the course to suit your needs. We aim to encourage learners to become responsible for their own learning, confident in discussing ideas, innovative and engaged.

We provide a range of support services designed to help you at every stage, from preparation through to the delivery of our specifications. This includes:

- A wide range of high-quality creative resources including:
  - delivery guides
  - transition guides
  - topic exploration packs
  - lesson elements
  - …and much more.
- Access to Subject Advisors to support you through the transition and throughout the lifetime of the specifications.
- CPD/Training for teachers to introduce the qualifications and prepare you for first teaching.
- Active Results – our free results analysis service to help you review the performance of individual students or whole schools.
- ExamBuilder – our free online past papers service that enables you to build your own test papers from past OCR exam questions.

All AS level qualifications offered by OCR are accredited by Ofqual, the Regulator for qualifications offered in England. The accreditation number for OCR's AS Level in Biology B (Advancing Biology) is QN: 601/4721/0.

## 1b. Why choose an OCR AS Level in Biology B (Advancing Biology)?

We appreciate that one size doesn't fit all so we offer two suites of qualifications in each science:

**Biology A** – Provides a flexible approach to teaching. The specification is divided into topics, each covering different key concepts of biology. Teaching of practical skills is integrated with the theoretical topics and they are assessed through the written papers. For A level only, the Practical Endorsement will also support the development of practical skills.

**Biology B (Advancing Biology)** – Learners study biology using a context based approach. Ideas are introduced within relevant and interesting settings which help learners to anchor their conceptual knowledge of the range of biological topics required at GCE level. Practical skills are embedded within the specification and learners are expected to carry out practical work in preparation for a written examination that will specifically test these skills.

All of our specifications have been developed with subject and teaching experts. We have worked in close consultation with teachers and representatives from Higher Education (HE) with the aim of including up-to-date relevant content within a framework that is interesting to teach and administer within all centres (large and small).

Biology B (Advancing Biology) is a new course for OCR.

It has been designed as an alternative approach to OCR Biology A. Advancing Biology, like OCRs other 'B' specifications, is designed in such a way as to give learners relevant and interesting contexts in which to set their study of complex biological ideas. For example, learners consider cell structure and function in the context of the blood and the cells found in it.

We've based the redevelopment of our A level sciences on an understanding of what works well in centres large and small. We've undertaken a significant amount of consultation through our science forums (which include representatives from learned societies, HE, teaching and industry) and through focus groups with teachers. Our papers and specifications have been trialled in centres during development to make sure they work well for all centres and learners.

The content changes will be familiar to centres already following our courses, but also clear and logically laid out for centres new to OCR, with assessment models that are straightforward to administer. We have worked closely with teachers and HE representatives to provide high quality support materials to guide you through the new qualifications

### Aims and learning outcomes

OCR's AS Level in Biology B (Advancing Biology) specification aims to encourage learners to:

- develop essential knowledge and understanding of different areas of the subject and how they relate to each other
- develop and demonstrate a deep appreciation of the skills, knowledge and understanding of scientific methods
- develop competence and confidence in a variety of practical, mathematical and problem solving skills
- develop their interest in and enthusiasm for the subject, including developing an interest in further study and careers associated with the subject
- understand how society makes decisions about scientific issues and how the sciences contribute to the success of the economy and society as exemplified in ('How Science Works' (HSW)).

## 1c. What are the key features of this specification?

Our Biology B (Advancing Biology) specification has been designed so learners study biology using an engaging, context-based approach. The specification:

- is laid out clearly in a series of teaching modules with Additional guidance added where required to clarify assessment requirements. Ideas are introduced within relevant and contemporary settings that help students to anchor their conceptual knowledge of the range of biological topics required at AS level
- is co-teachable with the A level
- embeds practical requirements within the teaching modules. Whilst the Practical Endorsement is not part of AS Level in Biology B (Advancing Biology) opportunities for carrying out activities that would count towards the Practical Endorsement are indicated throughout the specification, in the Additional guidance column, by use of **PAG**, refer to the A level specification, Section 5, for Practical Endorsement requirements
- exemplifies the mathematical requirements of the course (see Section 5)
- highlights opportunities for the introduction of key mathematical requirements (see Section 5 and the additional guidance column for each module) into your teaching
- identifies, within the Additional guidance how the skills, knowledge and understanding of How Science Works (HSW) can be incorporated within teaching.

### Teacher support

The extensive support offered alongside this specification includes:

- **delivery guides** – providing information on assessed content, the associated conceptual development and contextual approaches to delivery
- **transition guides** – identifying the levels of demand and progression for different key stages for a particular topic and going on to provide links to high quality resources and 'checkpoint tasks' to assist teachers in identifying learners 'ready for progression'
- **lesson elements** – written by experts, providing all the materials necessary to deliver creative classroom activities
- **Active Results** (see Section 1a)
- **ExamBuilder** (see Section 1a)
- **mock examinations service** – a free service offering a practice question paper and mark scheme (downloadable from a secure location).

Along with:

- Subject Advisors within the OCR science team to help with course queries
- teacher training
- *Science Spotlight* (our termly newsletter)
- OCR Science community
- Practical Skills Handbook
- Maths Skills Handbook.

## 1d. How do I find out more information?

Whether new to our specifications, or continuing on from our legacy offerings, you can find more information on our webpages at: **www.ocr.org.uk**

Visit our subject pages to find out more about the assessment package and resources available to support your teaching. The science team also release a termly newsletter *Science Spotlight*.

You can contact the Science Subject Advisors: **ScienceGCE@ocr.org.uk**, 01223 553998.

Visit our Online Support Centre at support.ocr.org.uk **https://support.ocr.org.uk**

Check what CPD events are available: **www.cpdhub.ocr.org.uk**

Follow us on Twitter: **@ocr_science**

# 2 The specification overview

## 2a. Overview of AS Level in Biology B (Advancing Biology) (H022)

Learners must complete both components (01 and 02) to be awarded the OCR AS Level in Biology B.

<table>
<tr><th>Content Overview</th><th colspan="2">Assessment Overview</th></tr>
<tr><td rowspan="2">Content is split into three teaching modules:<br>• Module 1 – Development of practical skills in biology<br>• Module 2 – Cells, chemicals for life and transport and gas exchange<br>• Module 3 – Cell division, development and disease control<br>Both components assess content from all three modules.</td><td>Foundations of biology (01)<br>70 marks<br>1 hour 30 minutes written paper</td><td>50%<br>of total AS level</td></tr>
<tr><td>Biology in depth (02)<br>70 marks<br>1 hour 30 minutes written paper</td><td>50%<br>of total AS level</td></tr>
</table>

Both components include synoptic assessment.

## 2b. Content of AS Level in Biology B (Advancing Biology) (H022)

The AS Level in Biology B (Advancing Biology) specification content is divided into three teaching modules and each module is further divided into key topics. Each module is introduced with a summary of the biology it contains. The assessable content is then divided into two columns: **Learning outcomes** and **Additional guidance**.

The Learning outcomes may all be assessed in the examination. The Additional guidance column is included to provide further advice on delivery and the expected skills required from learners.

References to HSW (Section 5) are included in the guidance to highlight opportunities to encourage a wider understanding of science.

The mathematical requirements in Section 5 are also referenced by the prefix M to link the mathematical skills required for A Level Biology to examples content where those mathematical skills could be linked to learning.

Module 1 of the specification content relates to the practical skills learners are expected to gain throughout the course, which are assessed throughout the written examinations.

Practical activities are embedded within the learning outcomes of the course to encourage practical activities in the classroom, enhancing learners' understanding of biological theory and practical skills.

The specification has been designed to be co-teachable with the A Level in Biology B (Advancing Biology) qualification. Learners studying the A level study modules 1 to 3 in year 12 and then continue with the A level only modules 4 and 5 in year 13. The internally assessed Practical Endorsement skills also form part of the full A Level (see module 1.2 in the A Level specification).

A summary of the content for the AS level course is as follows:

**Module 1 – Development of practical skills in biology**

1.1.1 Planning

1.1.2 Implementing

1.1.3 Analysis

1.1.4 Evaluation

**Module 2 – Cells, chemicals for life, transport and gas exchange**

2.1.1 Cells and microscopy

2.1.2 Water and its importance in plants and animals

2.1.3 Proteins and enzymes

2.1.4 Nucleic acids

2.2.1 The heart and monitoring heart function

2.2.2 Transport systems in mammals

2.2.3 Gas exchange in mammals and plants

2.2.4 Transport systems in plants

**Module 3 – Cell division, development and disease control**

3.1.1 The developing cell: cell division and cell differentiation

3.1.2 The developing individual: meiosis, growth and development

3.1.3 The development of species: evolution and classification

3.2.1 Pathogenic microorganisms

3.2.2 The immune system

3.2.3 Controlling communicable diseases

3.3.1 The cellular basis of cancer and treatment

3.3.2 Respiratory diseases and treatment

## 2c. Content of modules 1 to 3

### Module 1: Development of practical skills in biology

The development of practical skills is a fundamental and integral aspect of the study of any scientific subject. These skills not only enhance learners' understanding of the subject but also serve as a suitable preparation for the demands of studying biology at a higher level.

### 1.1 Practical skills assessed in a written examination

Practical skills are embedded throughout all sections of this specification.

Learners will be required to develop a range of practical skills throughout their course in preparation for the written examinations.

#### 1.1.1 Planning

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | experimental design, including to solve problems set in a practical context | Including selection of suitable apparatus, equipment and techniques for the proposed experiment.<br>Learners should be able to apply scientific knowledge based on the content of the specification to the practical context.<br>HSW3 |
| **(b)** | identification of variables that must be controlled, where appropriate | *M0.1* |
| **(c)** | evaluation that an experimental method is appropriate to meet the expected outcomes. | HSW6 |

#### 1.1.2 Implementing

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | how to use a wide range of practical apparatus and techniques correctly | As outlined in the content of the specification and the skills required for the Practical Endorsement.<br>HSW4 |
| **(b)** | appropriate units for measurements | *M0.1* |
| **(c)** | presenting observations and data in an appropriate format. | HSW8 |

### 1.1.3 Analysis

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | processing, analysing and interpreting qualitative and quantitative experimental results | Including reaching valid conclusions, where appropriate.<br>HSW5 |
| **(b)** | use of appropriate mathematical skills for analysis of quantitative data | Refer to Section 5c for a list of mathematical skills that learners should have acquired competence in as part of their course.<br>HSW3 |
| **(c)** | appropriate use of significant figures | *M1.1* |
| **(d)** | plotting and interpreting suitable graphs from experimental results, including: | |
| | **(i)** selection and labelling of axes with appropriate scales, quantities and units | *M3.2* |
| | **(ii)** measurement of gradients and intercepts. | *M3.3, M3.5* |

### 1.1.4 Evaluation

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | how to evaluate results and draw conclusions | HSW6 |
| **(b)** | the identification of anomalies in experimental measurements | |
| **(c)** | the limitations in experimental procedures | |
| **(d)** | precision and accuracy of measurements and data, including margins of error, percentage errors and uncertainties in apparatus | *M1.1, M1.11* |
| **(e)** | the refining of experimental design by suggestion of improvements to the procedures and apparatus. | HSW3 |

## Module 2: Cells, chemicals for life, transport and gas exchange

### 2.1 Cells and chemicals for life

This section provides learners with a knowledge and understanding of how the use of microscopy allowed the development of the cell theory, which is a unifying concept in biology. It also focuses on the importance of microscopy in investigating the structure of eukaryotic and prokaryotic cells. Learners will also gain an insight into some of the advanced microscopic techniques used by cell biologists today.

The structure of animal cells is studied in the context of the histology of mammalian blood as revealed by light microscopy and is contrasted with the structure of typical plant cells.

An understanding of the importance of enzyme-catalysed reactions is illustrated by the biochemical processes that prevent excessive blood loss, and learners investigate how first-aid and medical intervention can assist the body's natural mechanisms for preventing blood loss.

In addition to enzymes, this section covers the structures and functions of other biologically important molecules in animals and plants, including DNA, natural polymers, and the different mechanisms for transporting molecules into and out of living cells. Learners gain an appreciation of the importance of water in living organisms as the essential medium in which transport and exchange takes place.

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



#### 2.1.1 Cells and microscopy

| | | Learning outcomes | Additional guidance |
|---|---|---|---|
| | | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | **(i)** | the importance of microscopy in the development of the cell theory, as a unifying concept in biology, and the investigation of cell structure | To include the use of the light microscope, transmission and scanning electron microscopes and recent developments such as the confocal scanning microscope. |
| | **(ii)** | the preparation of blood smears (films) for use in light microscopy | To include how blood smears are made and the interpretation of stained material. Practical work to be carried out in accordance with current CLEAPSS guidelines. Also see Section 5f.<br>**PAG1**<br>HSW4, HSW6 |
| **(b)** | | the procedure for differential staining | To include the use of Leishman's stain to identify leucocytes in blood smears.<br>HSW4, HSW6 |
| **(c)** | **(i)** | the structure of animal cells as illustrated by a range of blood cells and components as revealed by the light microscope | To include red blood cells (erythrocytes), platelets, neutrophils, lymphocytes and monocytes as specialised cells with particular functions related to their structures. |
| | **(ii)** | the observation, drawing and annotation of cells in a blood smear as observed using the light microscope | **PAG1** |

| | | |
|---|---|---|
| **(d)** | the linear dimension of cells and the use and manipulation of the magnification formula<br><br>$\text{magnification} = \frac{\text{image size}}{\text{actual size (of object)}}$ | *M1.8*<br>**PAG1** |
| **(e)** | practical investigations using a haemocytometer to determine cell counts | To determine the numbers of erythrocytes and convert to a concentration (to include details of dilutions and calculations).<br>*M0.1, M0.2, M0.3, M1.5, M1.10, M4.1*<br>**PAG1**<br>HSW3, HSW4, HSW5, HSW6 |
| **(f)** | the principles and use of flow cytometry in blood analysis | To include the use of fluorescent labels. Details of the use of different lasers is not required.<br>HSW3, HSW8 |
| **(g)** | the ultrastructure of a typical eukaryotic animal cell, such as a leucocyte, as revealed by an electron microscope | To include the structure and function of the following: plasma membrane, Golgi apparatus, rough endoplasmic reticulum (RER) and smooth endoplasmic reticulum (SER), ribosomes, lysosomes, vesicles, mitochondria, cytoskeleton, centrioles, nucleus and nucleolus.<br>HSW8<br>*M1.8* |
| **(h)** | **(i)** the ultrastructure of a typical eukaryotic plant cell such as a palisade mesophyll cell and a prokaryotic cell, as revealed by an electron microscope<br><br>**(ii)** the similarities and differences between the structure of eukaryotic plant and animal cells, and between eukaryotic and prokaryotic cells | To include the structure and function of chloroplasts, large vacuole, tonoplast and the cell wall in plant cells, circular DNA, plasmids, mesosome, pili and flagella in prokaryotic cells.<br>HSW8 |
| **(i)** | practical investigations using a graticule and stage micrometer to calculate and measure linear dimensions of cells | To include the calibration of an eyepiece graticule using a stage micrometer, calculating the area of the field of view and measuring the sizes of organs, tissues, cells and organelles and calculating their magnification.<br>*M0.1, M0.2, M1.1, M1.2, M1.8, M2.2, M4.1*<br>**PAG1**<br>HSW3, HSW4, HSW8 |
| **(j)** | how the plasma membrane is composed of modified lipids and how the structure of triglycerides and phospholipids is related to their functions | To include reference to fatty acids, glycerol, phosphate groups, ester bonds and hydrophobic/ hydrophilic properties. |

| | | |
|---|---|---|
| **(k)** | the fluid mosaic model of the typical plasma membrane | To include the location and function of phospholipids, intrinsic proteins, extrinsic proteins, cholesterol, glycolipids and glycoproteins. |
| **(l)** | the movement of molecules across plasma membranes | To include diffusion and facilitated diffusion as passive methods of transport across membranes<br>**AND**<br>active transport, endocytosis and exocytosis as processes requiring ATP as an immediate source of energy.<br>HSW8 |
| **(m)** | practical investigation(s) into factors affecting diffusion rates in cells | To include the use of model cells and tissues such as beetroot.<br>*M0.1, M0.2, M1.1, M1.2, M3.1, M3.2, M3.3, M3.5, M3.6*<br>**PAG8**<br>HSW1, HSW2, HSW3, HSW4, HSW5, HSW6 |
| **(n)** | the roles of membranes within and at the surface of cells | |
| **(o)** | the interrelationship between the organelles involved in the production and secretion of proteins. | To include the role of the cytoskeleton and motor proteins, the nucleus, ribosomes, RER, Golgi and vesicles (no details of transcription and translation are required at this stage).<br>HSW8 |

## 2.1.2 Water and its importance in plants and animals

| | | Learning outcomes | Additional guidance |
|---|---|---|---|
| | | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | | the properties of water | To include the polar nature of the water molecule, hydrogen bonding and the role of water as a solvent. |
| **(b)** | **(i)** | the importance of water as a major constituent of cytoplasm, intracellular and extracellular fluids and as the essential transport medium in plants and animals | To include the transpiration stream, cell sap and the maintenance of turgor in plants, and plasma, serum, tissue fluid, lymph and urine in mammals.<br>*M0.1, M0.2, M0.3, M1.1, M1.2, M1.6, M3.1*<br>HSW5, HSW6 |
| | **(ii)** | analysis of secondary data on the composition of mammalian body fluids and plant extracts to illustrate the role of water as a solvent | To include solutes (sugars, amino acids, proteins), electrolytes (hydrogen ions, $H^+$, potassium ions, $K^+$, sodium ions, $Na^+$, chloride ions, $Cl^-$, hydrogencarbonate ions, $HCO_3^-$, magnesium ions, $Mg^{2+}$). |

| | | | |
|---|---|---|---|
| **(c)** | **(i)** | how sugar and protein molecules can be detected and measured in body fluids and plant extracts | To include the use of reagent test strips and biosensors to detect and measure the concentration of sugars and proteins.<br>*M0.1, M0.2, M0.3, M1.1, M1.2, M1.3, M1.6, M3.1, M3.2*<br>**PAG5, PAG9**<br>HSW3, HSW4, HSW5, HSW6 |
| | **(ii)** | the methodology and interpretation of the results of the Biuret test, Benedict's test and colorimetry | |
| **(d)** | | the importance of hydrolysis and condensation of biological molecules in cell metabolism | To include the relationship between monomers and polymers. |
| **(e)** | | the structure of the ring form of $\alpha$-glucose as an example of a simple monosaccharide, and lactose as a disaccharide | To include the concept of organic molecules as generally containing carbon atoms and a number of additional elements. |
| **(f)** | **(i)** | the formation of polysaccharides by condensation | To include glycogen and starch (amylose and amylopectin)<br>**AND**<br>the formation of 1,4- and 1,6-glycosidic bonds and reference to the significance of branching on solubility. |
| | **(ii)** | a test for the identification and measurement of starch | To include the qualitative test for starch using iodine and colorimetry.<br>**PAG5, PAG9** |
| **(g)** | | osmosis, in terms of the movement of water down a water potential gradient | To include the effect of solutes and electrolytes on the water potential of plant cells and animal cells and on solutions within organisms e.g. body fluids, plant sap.<br>*M0.3, M1.1, M1.2, M1.3, M3.1, M3.2, M3.4* |
| **(h)** | | practical investigation(s) into factors affecting osmosis in plant and animal cells. | M0.3, M1.1, M1.2, M1.3, M3.1, M3.2, M3.4<br>**PAG8**<br>HSW3, HSW4, HSW5, HSW6 |

## 2.1.3 Proteins and enzymes

| | | Learning outcomes | Additional guidance |
|---|---|---|---|
| | | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | **(i)** | the basic structure of an amino acid and the formation of peptide bonds | |
| | **(ii)** | the use of chromatography in the separation and identification of amino acids | To include calculation of retention (R*f*) values.<br>$Rf = \frac{\text{distance moved by the solute}}{\text{distance moved by the solvent}}$<br>Practical work to be carried out in accordance with current CLEAPSS guidelines with regards to the risks associated with the use of ninhydrin.<br>Also see Section 5d.<br>**PAG6** |
| **(b)** | | the molecular structure of globular proteins as illustrated by the structure of enzymes and haemoglobin | To include primary, secondary and tertiary structure in relation to enzymes, and quaternary structure and prosthetic groups in relation to haemoglobin. |
| **(c)** | | how the structure of globular proteins enable enzyme molecules to catalyse specific metabolic reactions | To include the role of tertiary structure in the specificity of the active site, the formation of enzyme substrate complexes and the lowering of the activation energy. |
| **(d)** | **(i)** | the factors affecting the rate of enzyme-catalysed reactions | *M0.1, M1.2, M1.3, M1.11, M3.1, M3.2, M3.3, M3.5, M3.6*<br>**PAG4**<br>HSW3, HSW4, HSW5, HSW6, HSW8 |
| | **(ii)** | practical investigations into the factors affecting the rate of enzyme-catalysed reactions | |
| **(e)** | **(i)** | the role of proteins in blood clotting, and blood clotting as an enzyme-controlled process | To include the role of platelets, damaged tissue, thromboplastin, calcium ions, prothrombin, thrombin, fibrinogen and fibrin. |
| | **(ii)** | the first-aid procedure to assist the blood clotting process and prevent excessive blood loss | HSW10, HSW11, HSW12 |
| **(f)** | | the use of enzymes and inhibitors in medical diagnosis and treatment | To include diagnostic enzymes (e.g. blood amylase and LDH) and enzymes and inhibitors used in medical treatment (e.g. streptokinase, aspirin and warfarin). |
| **(g)** | | the donation of blood, and the types and uses of stored blood products. | To include blood groups and a consideration of the other issues affecting blood donation<br>**AND**<br>the collection and use of whole blood, leuco-depleted blood, packed red cells, platelets, clotting factors and plasma.<br>HSW9, HSW10, HSW11, HSW12 |

## 2.1.4 Nucleic acids

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | the structure of a nucleotide as the monomer from which nucleic acids are made | To include the differences between RNA and DNA nucleotides, the identification of the purines and pyrimidines, the type of pentose sugar and the formation of phosphodiester bonds (the sugar phosphate 'backbone'). |
| **(b)** | the structure of adenosine di-phosphate (ADP) and adenosine tri-phosphate (ATP) as phosphorylated nucleotides | |
| **(c)** **(i)** | the structure of the DNA molecule, including a review of the evidence for complementary base pairing (Chargaff's rules) | *M0.3* |
| **(ii)** | practical investigation into the purification of DNA by precipitation | HSW3, HSW7 |
| **(d)** | semi-conservative DNA replication | To include the roles of the enzymes helicase and DNA polymerase, the importance of replication in conserving genetic information with accuracy and the occurrence of random, spontaneous mutations. |
| **(e)** | the nature of the genetic code | To include reference to the triplet, non-overlapping, degenerate and universal nature of the code and how a gene determines structure of proteins including enzymes by ordering the sequence of amino acids in a polypeptide. |
| **(f)** | the structure of RNA (ribonucleic acid) and how it differs from that of DNA | |
| **(g)** | transcription and translation of genes resulting in the synthesis of polypeptides. | To include the role of RNA polymerase, messenger (m)RNA, transfer (t)RNA and ribosomal (r)RNA (details of post transcriptional modification are not required). |

## 2.2 Transport and gas exchange systems

This section provides learners with a knowledge and understanding of the structure and functions of the transport and gas exchange systems in mammals and multicellular terrestrial plants.

Learners will gain an appreciation of the need for mass transport systems and the significance of the surface area to volume ratio in multicellular organisms. The mass flow of materials within mammals and the exchange of molecules are studied in the context of the need to maintain a high metabolic rate.

Technological advances enable the activity of the heart, circulation and gas exchange systems to be monitored. Learners will be able to apply their knowledge of physiology to the interpretation of data on vital measurements of heart function, blood pressure and pulmonary ventilation. The importance of timely emergency treatment in both cardiac and respiratory arrest is also studied.

In this section, learners gain an understanding of the transport systems of terrestrial plants. In crop plants, the sites where organic molecules are stored – the harvestable parts of the plant – are often different to the sites where these molecules are produced – the leaves. This means that these molecules must be moved around the plant as required. The movement of water through a plant is, however, mainly due to physical mechanisms and processes. Learners will investigate the transport systems of multicellular plants and the different tissues involved. They will gain an appreciation of how the distribution of these tissues varies between different types of plants and that this distribution is diagnostic of the type of crop plant (broad-leaved or cereal) and the structural part of the plant (stem or root).



### 2.2.1 The heart and monitoring heart function

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | the need for a mass transport system in mammals | To include references to a high basal metabolic rate, being multicellular and the significance of surface area to volume ratio.<br>$\text{Ratio} = \frac{\text{Surface Area}}{\text{Volume}}$<br>*M0.3, M4.1* |
| **(b)** **(i)** | the internal and external structure of the mammalian heart | **PAG2**<br>HSW3, HSW4, HSW5, HSW6, HSW8 |
| **(ii)** | the examination, dissection and drawing of the mammalian heart | |
| **(c)** | the cardiac cycle | To include the role of the valves and the pressure changes occurring in the heart and associated vessels. |
| **(d)** | how heart action is initiated and co-ordinated | To include the roles of the sino-atrial node (SAN), atrio-ventricular node (AVN), purkyne tissue and the myogenic nature of cardiac muscle (no detail on hormonal and nervous control is required at AS level but at A level this is covered in 5.3.1(b)). |

| | | |
|---|---|---|
| **(e)** | practical investigation(s) into the factors affecting heart rate | To include the effect of exercise.<br>*M0.1, M0.4, M1.2, M1.3, M1.11, M2.3, M2.4, M3.1, M3.2*<br>**PAG10**<br>HSW3, HSW4, HSW5, HSW6 |
| **(f)** | the effect of heart rate on cardiac output | To include calculations based on heart rate and stroke volume.<br>cardiac output = heart rate × stroke volume<br>*M0.1, M0.4, M1.2, M1.3, M1.11, M2.3, M2.4, M3.1, M3.2*<br>**PAG10**<br>HSW3, HSW4, HSW5, HSW6 |
| **(g)** | the measurement and interpretation of pulse rate, to include the generation of primary data and the use of secondary data | M0.1, M0.4, M1.2, M1.3, M1.10, M1.11, M3.1, M3.2<br>**PAG10**<br>HSW3, HSW4, HSW5, HSW6 |
| **(h)** | the use and interpretation of an electrocardiogram (ECG) | To include tachycardia, bradycardia, S-T elevation and fibrillation.<br>*M3.1*<br>HSW3, HSW5 |
| **(i)** | the emergency treatment given to a person suffering a suspected heart attack or cardiac arrest. | To include the first-aid treatment for a heart attack and cardiac arrest<br>**AND**<br>the use of a defibrillator following cardiac arrest. |

## 2.2.2 Transport systems in mammals

| | | Learning outcomes | Additional guidance |
|---|---|---|---|
| | | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | | the importance of the closed double circulatory system | To include reference to blood pressure in systemic and pulmonary systems. |
| **(b)** | **(i)** | the structure and functions of arteries, arterioles, capillaries, venules and veins | HSW4, HSW5, HSW6 |
| | **(ii)** | transverse sections of arteries, veins and capillaries as observed using a light microscope | Prepared slides or photomicrographs may be examined to show the structural differences between these vessels. |
| **(c)** | | the formation and importance of tissue fluid | To include references to HP (hydrostatic pressure) and OP (oncotic pressure or colloidal osmotic pressure). |
| **(d)** | **(i)** | the use of a sphygmomanometer to measure systolic and diastolic blood pressure | To include reference to both manual and electronic measuring. |
| | **(ii)** | comparisons of blood pressure readings | HSW3, HSW4, HSW5, HSW6 |
| **(e)** | | the interpretation of systolic and diastolic blood pressure measurements | To include hypertension and hypotension and their possible consequences. |

## 2.2.3 Gas exchange in mammals and plants

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | **(i)** the relationships between cells, tissues and organs, in the mammalian gas exchange system | To include the appearance and the histology of squamous epithelial cells in the alveoli, ciliated epithelial tissue, smooth muscle, cartilage and elastic fibres. |
| | **(ii)** observations of tissues of the gas exchange system using microscopy | **PAG1**<br>HSW4, HSW5, HSW6 |
| **(b)** | the process of gas exchange in the alveoli | To include the roles of ventilation, epithelial tissue, smooth muscle, cartilage, elastic fibres, blood capillaries and surfactant in the establishment and maintenance of concentration gradients. |
| **(c)** | the parameters affecting pulmonary ventilation | To include consideration of tidal volume, breathing rate, vital capacity, residual volume, PEFR and $FEV_1$ (no detail of the use of a spirometer is required).<br>**PAG10**<br>M0.1, M2.2, M2.3, M2.4 |
| **(d)** | how expired air resuscitation can be carried out on adults, children and babies in cases of respiratory arrest. | To include reference to both manual and electronic methods.<br>HSW3, HSW4, HSW5, HSW6 |
| **(e)** | the process of gas exchange in terrestrial plants | To include the diffusion of gases between the atmosphere and intercellular spaces of leaves via stomata and through the lenticels of stems. |
| **(f)** | **(i)** the structure of stomata, their opening and closing | To include reference to changes in turgor and water potential of guard cells and the need for ATP. |
| | **(ii)** the microscopic appearance of stomata | To include the appearance of stomata in the leaves of different terrestrial plants.<br>**PAG1** |

## 2.2.4 Transport systems in plants

| | | | Learning outcomes | Additional guidance |
|---|---|---|---|---|
| | | | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | | | the need for transport systems in multicellular plants | To include references to size, variations in metabolic rate and the significance of surface area to volume ratio. |
| **(b)** | | | the structure, function and location of vascular tissues in roots, stems and leaves | To include xylem vessels, sieve tube elements and companion cells in the roots, stems and leaves of monocotyledonous crop plants (cereals) and dicotyledonous crop plants (broad-leaved crops e.g. carrots, potatoes) |
| **(c)** | **(i)** | | the observation, drawing and annotation of stained sections of plant tissues using a light microscope | *M0.1, M0.2, M1.1, M1.2, M1.8, M2.1*<br>**PAG1**<br>HSW2, HSW3, HSW4, HSW5, HSW8 |
| | **(ii)** | | the longitudinal and transverse dissection and examination of plant organs to demonstrate the position and structure of vascular tissue | **PAG2**<br>HSW2, HSW3, HSW4, HSW5, HSW8 |
| **(d)** | | | the entry and transport of water in terrestrial plants | To include details of the pathways taken by water<br>**AND**<br>the mechanisms of movement, including adhesion, cohesion and the transpiration stream, in terms of water potential.<br>HSW2, HSW8 |
| **(e)** | **(i)** | | the process of transpiration and the environmental factors that affect the transpiration rate | To include an appreciation that transpiration occurs due to physical processes linked to gaseous exchange in leaves. |
| | **(ii)** | | practical investigations to estimate transpiration rates | *M0.1, M0.2, M1.1, M1.2, M1.3, M1.6, M1.11, M3.1, M3.2, M3.3, M3.5, M3.6, M4.1*<br>**PAG5, PAG11**<br>HSW2, HSW3, HSW4, HSW5, HSW6, HSW8 |
| **(f)** | | | the mechanism of translocation | To include translocation in the phloem as an energy-requiring process transporting assimilates, especially sucrose, between sources (e.g. leaves) and harvestable sinks (e.g. roots, stems and seeds)<br>**AND**<br>details of active loading at the source and removal at the sink. |

## Module 3: Cell division, development and disease control

### 3.1 Cell division and development

This section provides learners with knowledge and understanding of biological development on three levels: cell division by mitosis (where genetic information is copied and passed to daughter cells) and cell differentiation, cell division by meiosis and fetal development, and the evolutionary development of species.

Scientific research has highlighted the role of apoptosis during the life cycle of a multicellular organism. The importance of both mitosis and apoptosis is considered in relation to fetal growth and development, as well as an appreciation that these processes are affected by environmental factors. Knowledge of recent advancements in stem cell technology and its potential applications further enhance learners' understanding of these fundamental cellular processes.

Meiosis is also studied as a process that promotes genetic biodiversity and variation. The potential for change and the development of new species by the action of natural selection on genetic variation is seen as an essential part of the process of evolution. Learners will also gain an understanding that the variety of life, both past and present, is extensive, but the biochemical basis of life is similar for all living things as well as of the link between natural selection and the adaptations of living organisms to their environments.

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

#### 3.1.1 The developing cell: cell division and cell differentiation

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | the cell cycle | To include the processes taking place during interphase ($G_1$,S and $G_2$), mitosis and cytokinesis, leading to genetically identical daughter cells. |
| **(b)** **(i)** | the changes that take place in the nuclei and cells of animals and plants during mitosis | To include the changes in the nuclear envelope and the behaviour of the centrioles, spindle fibres, centromere, chromatids and chromosomes, and the formation of the cell plate in plant cells. |
| **(ii)** | the microscopic appearance of cells undergoing mitosis | To include the examination and drawing of stained sections or squashes of plant tissue and the identification of the stages observed.<br>**PAG1**<br>HSW4, HSW5, HSW6 |
| **(c)** | the principal stages and features of apoptosis | To include cell shrinkage, nuclear condensation (pyknosis), blebs, nuclear fragmentation (karyorrhexis), the roles of phosphatidylserine and macrophages. |
| **(d)** | the importance of apoptosis and mitosis in growth and repair | To include examples of the roles of apoptosis in cell deletion and mitosis in cell addition. |
| **(e)** **(i)** | the differentiation of stem cells into specialised cells | To include an appreciation of the differences between totipotent, pluripotent and multipotent stem cells, and the differentiation of bone marrow stem cells into specialised blood cells. |
| **(ii)** | current applications and uses of stem cells. | To include the use of bone marrow stem cells. |

## 3.1.2 The developing individual: meiosis, growth and development

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | the significance of meiosis in sexual reproduction and the production of haploid gametes in plants and animals | To include the importance of meiosis in maintaining the chromosome number at fertilisation and between generations. |
| **(b)** | the stages of meiosis in plant and animal cells | To include the use of diagrams to describe interphase, prophase 1, metaphase 1, anaphase 1, telophase 1, prophase 2, metaphase 2, anaphase 2, telophase 2 (no details of the names of the stages within prophase 1 are required).<br>**PAG1** |
| **(c)** | how meiosis produces daughter cells that are genetically different | To include the importance of chiasma formation, crossing over, independent assortment of chromosomes (metaphase 1) and chromatids (metaphase 2) in producing genetic variation. |
| **(d)** | the programme of antenatal care in the United Kingdom | To include pre-conceptual care and post-conceptual care. |
| **(e)** | the dietary changes recommended during pregnancy | To include the roles of protein, calcium, iron, vitamin A, vitamin C and folic acid<br>**AND**<br>the reasons for changes in DRV recommendations of these nutrients and energy during pregnancy. |
| **(f)** | the effects of alcohol consumption and smoking on fetal growth and development | |
| **(g)** **(i)** | the use of ultrasound for measuring fetal growth | To include the measurement of biparietal diameter of the cranium, crown-rump length of the back.<br>*M0.1, M0.3, M1.3, M1.4, M1.6* |
| **(ii)** | the analysis of secondary data from fetal growth charts | |
| **(h)** | the advantages and disadvantages of techniques for assessing fetal development and detecting disorders | To include fetal ultrasonography, amniocentesis and chorionic villus sampling. |
| **(i)** | the production and use of karyotypes. | To include the use of karyotypes in fetal sex identification and the diagnosis of chromosomal mutations. To include Down's syndrome, Klinefelter's syndrome and Turner's syndrome (no details of non-disjunction are required at AS level). |

## 3.1.3 The development of species: evolution and classification

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | the concepts of biological classification and species | To include the taxonomic ranks in the hierarchy of classification (domain, kingdom, phylum, class, order, family, genus, species)<br>**AND**<br>an outline of the biological and phylogenetic species concepts. |
| **(b)** | the types of evidence used in biological classification and consideration of how theories change as new evidence is found | Evidence for hominid classification to include observable features (e.g. fossils) and molecular evidence (e.g. DNA).<br>HSW7, HSW8 |
| **(c)** | the use of DNA barcoding in biological classification, examples of the genes used and consideration of the reasons for the choice of these genes | To include the use of mitochondrial genes (e.g. cytochrome c oxidase 1) in animals, and chloroplast genes in plants (no details of electrophoresis are required at AS level but at A level this is covered in 5.1.3 (d)). |
| **(d)** | the interpretation of phylogenetic trees and genetic data to show relatedness and classification in plants and animals | To include consideration of hominids, both extinct and extant, and hylobatids, including examples in which there is conflicting evidence.<br>HSW5, HSW6, HSW8 |
| **(e)** | **(i)** behavioural, physiological and anatomical adaptations to the environment | To include the following adaptations in *Homo sapiens*: tool use and cultural adaptations for social bonding (behavioural), lactose tolerance and skin pigmentation (physiological), bipedalism and brain size (anatomical)<br>**AND**<br>adaptations of plants to their environment including adaptations to extremes of temperature, light and water. |
| | **(ii)** practical investigation into adaptations of plants to environmental factors | |
| **(f)** | the evolution of language as an example of a scientific question with many competing theories | To include discussion of why some scientific questions (e.g. "how did language evolve?") are difficult to answer because of a lack of evidence, and consideration of competing theories (to include the "mother tongues" and "gossip" hypotheses).<br>HSW1, HSW2, HSW3, HSW7, HSW8 |
| **(g)** | adaptation and selection as components of evolution | To include the ideas of genetic variation, selection pressures and natural selection in relation to evolution. |

| | | |
|---|---|---|
| **(h)** | the definition and measurement of biodiversity | To include calculating Simpson's Index of Diversity ($D$). The formula will be provided where needed in assessments and does not need to be recalled.<br>$D = 1 - \left(\sum\left(\frac{n}{N}\right)^2\right)$<br>To include a consideration that biodiversity can exist at the genetic, species and ecosystem levels.<br>*M01, M0.2, M1.1, M2.2, M2.4* |
| **(i)** | the calculations of genetic diversity within populations. | To include the percentage of gene variants (alleles) in a genome.<br>$\text{proportion of polymorphic gene loci} = \frac{\text{number of polymorphic gene loci}}{\text{total number of loci}}$<br>M0.1, M0.2, M1.1, M2.2, M2.4 |

## 3.2 Pathogens, immunity and disease control

In this section, learners study the nature of pathogens and their means of transmission. An understanding of the primary defences and immunological responses of the body to infection, and the management and treatment of communicable diseases will also be considered, including the challenges of controlling the spread of drug-resistant strains. Learners will also gain an appreciation of the need for epidemiological research in this dynamic and changing area of science, and evaluate the associated risks and benefits to the individual and to society.

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

### 3.2.1 Pathogenic microorganisms

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | how pathogens (including bacteria, viruses and fungi) cause communicable disease | To include an outline of the general mechanisms of pathogenicity by bacteria (toxin production), viruses (taking over cell metabolism) and fungi (enzyme secretion). |
| **(b)** | the causes, means of transmission, symptoms and the principal treatment of tuberculosis (TB) and HIV/AIDS | To include droplet infection, details of primary and secondary TB and also opportunistic infections (HIV-AIDS).<br>HSW10 |
| **(c)** | the structure of the Human Immunodeficiency Virus (HIV) | To include the use of diagrams showing the location of enzymes and the nature of the genetic material. |
| **(d)** **(i)** | the use of Gram stain, cell and colony morphology to identify bacteria | |
| **(ii)** | the culturing of bacteria and the identification of Gram-positive and Gram-negative bacteria using the Gram staining method on pure cultures | HSW3, HSW4, HSW5, HSW6, HSW8 |

| | | |
|---|---|---|
| **(e)** | how the incidence and prevalence of a communicable disease can change over time | To include the principles of endemic communicable diseases (e.g. chickenpox in the UK), epidemics (e.g. SARS in China, 2002) and pandemics (e.g. H1N1 influenza in 2009). |
| **(f)** | calculations of incidence rates, prevalence rates and mortality rates and their importance in epidemiology | *M0.1, M0.3, M0.4* |
| **(g)** | the analysis, interpretation and use of epidemiological data | To include the evaluation of graphical data to assess the impact of disease e.g. for HIV and TB infection.<br>*M1.3, M1.7, M3.1, M3.5, M3.6*<br>HSW12 |
| **(h)** | the importance of reporting notifiable diseases and the role of Public Health England, formerly known as the Health Protection Agency (HPA) | To include examples of notifiable diseases.<br>HSW12 |
| **(i)** | the social, ethical, economic and biological factors involved in the attempts to control and prevent diseases in the context of HIV/AIDS and TB. | HSW10 |

### 3.2.2 The immune system

| | **Learning outcomes** | **Additional guidance** |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | primary defences and non-specific defences against pathogens | Primary defences to include mucus and cilia in the respiratory tract, lysozyme in tears and stomach acid<br>**AND**<br>non-specific immune responses to include phagocytosis and inflammation. |
| **(b)** | the mode of action of phagocytes | To include the roles of cytokines, opsonins, phagosomes and lysosomes. |
| **(c)** | the different roles and modes of action of B and T lymphocytes in the specific immune response | To include clonal selection and clonal expansion, plasma cells, T helper cells, T killer cells and T regulatory cells. |
| **(d)** | the secondary immune response and the role of memory cells in long term immunity | To include T memory cells and B memory cells. |
| **(e)** | the structure and general function(s) of antibodies | To include descriptions of antibody structure from diagrams<br>**AND**<br>an outline of the action of opsonins and agglutinins. |
| **(f)** | how individuals can be tested for TB and HIV infection | To include antibody tests and antigen tests for both diseases<br>**AND**<br>the Mantoux test for TB. |

| | | |
|---|---|---|
| **(g)** | the differences between active and passive immunity, and between natural and artificial immunity | To include examples of each type of immunity. |
| **(h)** | how allergies can result from hypersensitivity of the immune system. | To include an outline of the sequence of events in a typical allergic response to allergens such as pollen (hay fever). |



### 3.2.3 Controlling communicable diseases

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | the principles of vaccination | To include the different forms of vaccines (live vaccine, dead microorganisms, pathogen fragments) and the importance of booster vaccinations. |
| **(b)** | the role of vaccination programmes in the prevention of epidemics | To include reference to the establishment of herd immunity. |
| **(c)** | the biological problems in the development of vaccines and the use of vaccination programmes | To include issues with vaccine development, mutation rate and antigen variability (e.g. in HIV and the influenza virus(es)) and live vaccines.<br>**AND**<br>vaccine use – storage of vaccine, distribution of vaccine and the nutritional status of the target population e.g. if protein deficient. |
| **(d)** | the ethical issues related to the development and use of vaccines | To include the use of a vaccine in girls against Human Papilloma Virus (HPV) to prevent cervical cancer.<br>HSW10 |
| **(e)** | the use of antibiotics in the treatment of communicable disease | To include an outline of the modes of action of antibiotics e.g. inhibition of bacterial protein, DNA and cell wall synthesis<br>**AND**<br>the cellular differences between prokaryotic and eukaryotic cells that allow antibiotics to act on bacterial but not human cells. |
| **(f)** | how the misuse of antibiotics can lead to the evolution of resistant strains of bacteria | To include reference to TB and MRSA. |
| **(g)** | practical investigations on the effect of antibiotics on Gram-positive and Gram-negative bacteria. | To include bacteriostatic and bacteriocidal effects of antibiotics and the effect of disinfectant use and other hygiene practices.<br>**PAG1, PAG7**<br>HSW3, HSW4, HSW5, HSW6, HSW8 |

## 3.3 Non-communicable diseases

In this section, an understanding of non-communicable diseases will be illustrated by reference to cancer, smoking-induced lung diseases and asthma.

Learners will use their knowledge of cell division from Module 3.1 to further their understanding of the cellular and genetic basis of cancer. The computerised technological devices and tests that enable early detection and diagnosis of cancer will also be considered, as well as the use of genetic screening to assess potential risks.

Consideration will be given to the analysis of epidemiological data when evaluating the causes of non-infectious diseases, and learners will consider the importance of clinical trials when developing new medicinal treatments. The role of government health agencies in providing national guidelines for treatments is also explored.

In this section, learners will consider the biological and ethical implications of medical and scientific advancements and evaluate the associated risks and benefits to society as well as an appreciation of the relevance of sustainability to all aspects of scientific developments (for instance the importance of plants as food as well as potential sources of medicinal drugs).

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



### 3.3.1 The cellular basis of cancer and treatment

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | the factors that may increase the risk of developing non-communicable diseases | Factors to include heredity, ageing, types of radiation, carcinogen, viruses and air pollution and diseases to include cancers and asthma<br>**AND**<br>to include an evaluation of epidemiological and other evidence to identify correlations. |
| **(b)** | the cellular basis of cancer | To include an outline of cell cycle control and the changes in control which lead to the formation of tumours and metastases. |
| **(c)** | how mutations to proto-oncogenes can lead to cancer | To include Ras and Myc proto-oncogenes. |
| **(d)** | how mutations to tumour suppressor genes can lead to cancer | To include the p53 gene. |
| **(e)** | the evaluation of epidemiological evidence linking potential risk factors with particular forms of cancer | To include smoking and lung cancer, diet and bowel cancer, BRCA1 gene mutations and breast cancer.<br>*M1.3, M1.5, M1.7, M3.1*<br>HSW5, HSW6 |
| **(f)** | the methods used to detect cancers | To include references to MRI, X-rays, mammography, CT scans, ultrasound, PET scans, biopsies and blood tests. |

| | | |
|---|---|---|
| **(g)** | the ethical and economic considerations when screening and conducting genetic tests for cancer | To include evaluation of screening for particular cancers e.g. the potential harm, accuracy and cost of the screening procedure<br>**AND**<br>discussion of the ethics of genetic tests e.g. for BRCA and HNPCC genes.<br>HSW9, HSW10 |
| **(h)** | the methods used to treat patients with cancer. | To include surgery, chemotherapy, radiotherapy, immunotherapy (monoclonal antibodies), complementary therapies and hormone-related treatment. |



### 3.3.2 Respiratory diseases and treatment

| | Learning outcomes | Additional guidance |
|---|---|---|
| | *Learners should be able to demonstrate and apply their knowledge and understanding of:* | |
| **(a)** | the short-term and long-term effects of pollutants on the respiratory system | To include tobacco smoke, asbestos and fungal spores. |
| **(b)** | the causes and symptoms of chronic bronchitis and emphysema (COPD), asthma and lung cancer | |
| **(c)** | comparisons of acute and chronic diseases | |
| **(d)** | the treatment of asthma | To include the use of beta agonists and steroids. |
| **(e)** | the importance of plants as potential sources of medicinal drugs | To include the use of theophylline (from *Theobroma cacao*) in the treatment of COPD and asthma, topotecan (from *Camptotheca acuminata*) in the treatment of lung cancer, aspirin (from *Salix spp.*) and quinine (from *Cinchona spp.*). |
| **(f)** | the design and use of clinical trials to assess the value of treatments | To include the role of each phase of a clinical trial and the importance of the recruitment and size of sample, randomisation, placebos and double-blind trials.<br>*M1.5*<br>HSW9, HSW10, HSW11 |
| **(g)** | the role of NICE (National Institute for Health and Care Excellence) in providing guidelines for treatments. | To include its role in providing guidelines on clinical practice, health technologies and public health<br>**AND**<br>the importance of economic considerations in the production of guidelines.<br>HSW9, HSW10, HSW11 |

## 2d. Prior knowledge, learning and progression

This specification has been developed for learners who wish to continue with a study of biology at Level 3 in the National Qualifications Framework (NQF). The AS level specification has been written to provide progression from GCSE Science, GCSE Additional Science, GCSE Further Additional Science or from GCSE Biology. Learners who have successfully taken other Level 2 qualifications in Science or Applied Science with appropriate biology content may also have acquired sufficient knowledge and understanding to begin the AS Level Biology course.

There is no formal requirement for prior knowledge of biology for entry onto this qualification.

Other learners without formal qualifications may have acquired sufficient knowledge of biology to enable progression onto the course.

Some learners may wish to follow a biology course for only one year as an AS, in order to broaden their curriculum, and to develop their interest and understanding of different areas of the subject. Others may follow a co-teachable route, completing the one-year AS course and/or then moving to the two-year A level. For learners wishing to follow an apprenticeship route or those seeking direct entry into biological science careers, this AS level provides a strong background and progression pathway.

There are a number of Science specifications at OCR. Find out more at www.ocr.org.uk

# 3 Assessment of OCR AS Level in Biology B (Advancing Biology)

## 3a. Forms of assessment

Both externally assessed components (01 and 02) contain some synoptic assessment. Component 02 contains some extended response questions.

### Foundations of biology (Component 01)

This component is split into two sections and assesses content from all teaching modules. Learners answer all questions. This component is worth 70 marks.

**Section A** contains multiple choice questions. This section of the paper is worth 20 marks.

**Section B** includes short answer question styles (structured questions, problem solving, calculations, practical) and extended response questions. This section of the paper is worth 50 marks.

### Biology in depth (Component 02)

This component assesses content from across all teaching modules. Learners answer all questions. This component is worth 70 marks.

Question styles include short answer (structured questions, problem solving, calculations, practical) and extended response questions.

## 3b. Assessment objectives (AO)

There are three assessment objectives in OCR's AS Level in Biology B (Advancing Biology).

These are detailed in the table below.

Learners are expected to demonstrate their ability to:

| | Assessment Objective |
|---|---|
| **AO1** | Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures. |
| **AO2** | Apply knowledge and understanding of scientific ideas, processes, techniques and procedures:<br>• in a theoretical context<br>• in a practical context<br>• when handling qualitative data<br>• when handling quantitative data. |
| **AO3** | Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to:<br>• make judgements and reach conclusions<br>• develop and refine practical design and procedures. |

### AO weightings in AS Level in Biology B (Advancing Biology)

The relationship between the assessment objectives and the components are shown in the following table:

| Component | % of AS Level in Biology B (H022) | | |
|---|---|---|---|
| | AO1 | AO2 | AO3 |
| Foundations of biology (H022/01) | 22–24 | 19–20 | 7–9 |
| Biology in depth (H022/02) | 13–16 | 21–24 | 13–14 |
| **Total** | **35–40** | **40–44** | **20–23** |



## 3c. Total qualification time

Total qualification time (TQT) is the total amount of time, in hours, expected to be spent by a learner to achieve a qualification. It includes both guided learning hours and hours spent in preparation, study, and assessment. The total qualification time for AS Level in Biology B (Advancing Biology) is 180 hours. The total guided learning time is 180 hours.

## 3d. Qualification availability outside of England

This qualification is available in England. For Wales and Northern Ireland please check the Qualifications in Wales Portal (QIW) or the Northern Ireland Department of Education Performance Measures / Northern Ireland Entitlement Framework Qualifications Accreditation Number (NIEFQAN) list to see current availability.

## 3e. Language

This qualification is available in English only. All assessment materials are available in English only and all candidate work must be in English.

## 3f. Assessment availability

There will be one examination series available each year in May/June for **all** learners. All examined components must be taken in the same examination series at the end of the course.

This specification will be certificated from the June 2016 examination series onwards.

## 3g. Retaking the qualification

Learners can retake the qualification as many times as they wish. They retake both components of the qualification.

## 3h. Assessment of extended responses

The assessment materials for this qualification provide learners with the opportunity to demonstrate their ability to construct and develop a sustained and coherent line of reasoning and marks for extended responses are integrated into the marking criteria.



## 3i. Synoptic assessment

Synoptic assessment tests the learners' understanding of the connections between different elements of the subject.

Synoptic assessment involves the explicit drawing together of knowledge, understanding and skills learned in different parts of the AS level course. The emphasis of synoptic assessment is to encourage the development of the understanding of the subject as a discipline. Both components within Biology B (Advancing Biology) contain an element of synoptic assessment.

Synoptic assessment requires learners to make and use connections within and between different areas of biology, for example, by:

- applying knowledge and understanding of more than one area to a particular situation or context
- using knowledge and understanding of principles and concepts in planning experimental and investigative work and in the analysis and evaluation of data
- bringing together scientific knowledge and understanding from different areas of the subject and applying them.

## 3j. Calculating qualification results

A learner's overall qualification grade for AS Level in Biology B (Advancing Biology) will be calculated by adding together their marks from the two components taken to give their total weighted mark.

This mark will then be compared to the qualification level grade boundaries for the relevant exam series to determine the learner's overall qualification grade.

# 4 Admin: what you need to know

The information in this section is designed to give an overview of the processes involved in administering this qualification so that you can speak to your exams officer. All of the following processes require you to submit something to OCR by a specific deadline.

More information about the processes and deadlines involved at each stage of the assessment cycle can be found in the Administration area of the OCR website.

OCR's Admin overview is available on the OCR website at http://www.ocr.org.uk/administration.

## 4a. Pre-assessment

### Estimated entries

Estimated entries are your best projection of the number of learners who will be entered for a qualification in a particular series. Estimated entries should be submitted to OCR by the specified deadline. They are free and do not commit your centre in any way.

### Final entries

Final entries provide OCR with detailed data for each learner, showing each assessment to be taken. It is essential that you use the correct entry code, considering the relevant entry rules.

Final entries must be submitted to OCR by the published deadlines or late entry fees will apply.

All learners taking AS Level in Biology B (Advancing Biology) must be entered for H022.

| Entry option | | Components | | |
|---|---|---|---|---|
| Entry code | Title | Code | Title | Assessment type |
| H022 | Biology B (Advancing Biology) | 01 | Foundations of biology | External assessment |
| | | 02 | Biology in depth | External assessment |

### Private candidates

Private candidates may enter for OCR assessments.

A private candidate is someone who pursues a course of study independently but takes an examination or assessment at an approved examination centre. A private candidate may be a part-time student, someone taking a distance learning course, or someone being tutored privately. They must be based in the UK.

Private candidates need to contact OCR approved centres to establish whether they are prepared to host them as a private candidate. The centre may charge for this facility and OCR recommends that the arrangement is made early in the course.

Further guidance for private candidates may be found on the OCR website: http://www.ocr.org.uk

### Head of centre annual declaration

The Head of Centre is required to provide a declaration to the JCQ as part of the annual NCN update, conducted in the autumn term, to confirm that the centre is meeting all of the requirements detailed in the specification.

Any failure by a centre to provide the Head of Centre Annual Declaration will result in your centre status being suspended and could lead to the withdrawal of our approval for you to operate as a centre.

### Collecting evidence of student performance to ensure resilience in the qualifications system

Regulators have published guidance on collecting evidence of student performance as part of long-term contingency arrangements to improve the resilience of the qualifications system. You should review and consider this guidance when delivering this qualification to students at your centre.

For more detailed information on collecting evidence of student performance please visit our website at: **https://www.ocr.org.uk/administration/general-qualifications/assessment/**

## 4b. Accessibility and special consideration

Reasonable adjustments and access arrangements allow learners with special educational needs, disabilities or temporary injuries to access the assessment and show what they know and can do, without changing the demands of the assessment.

Applications for these should be made before the examination series. Detailed information about eligibility for access arrangements can be found in the JCQ *Access Arrangements and Reasonable Adjustments.*

Special consideration is a post-assessment adjustment to marks or grades to reflect temporary injury, illness or other indisposition at the time the assessment was taken.

Detailed information about eligibility for special consideration can be found in the JCQ *A guide to the special consideration process.*

## 4c. External assessment arrangements

Regulations governing examination arrangements are contained in the JCQ *Instructions for conducting examinations*.

Learners are permitted to use a scientific or graphical calculator for both components. Calculators are subject to the rules in the document *Instructions for Conducting Examinations* published annually by JCQ (**www.jcq.org.uk**).

## 4d. Results and certificates

### Grade scale

Advanced Subsidiary qualifications are graded on the scale: A, B, C, D, E, where A is the highest. Learners who fail to reach the minimum standard for E will be Unclassified (U). Only subjects in which grades A to E are attained will be recorded on certificates.

### Results

Results are released to centres and learners for information and to allow any queries to be resolved **before** certificates are issued.

Centres will have access to the following results information for each learner:

- the grade for the qualification
- the raw mark for each component
- the total weighted mark for the qualification.

The following supporting information will be available:

- raw mark grade boundaries for each component
- weighted mark grade boundaries for the qualification.

Until certificates are issued, results are deemed to be provisional and may be subject to amendment. A learner's final results will be recorded on an OCR certificate.

The qualification title will be shown on the certificate as 'OCR Level 3 Advanced Subsidiary GCE in Biology B (Advancing Biology)'.

## 4e. Post-results services

A number of post-results services are available:

- **Review of results** – If you are not happy with the outcome of a learner's results, centres may request a review of marking.
- **Missing and incomplete results** – This service should be used if an individual subject result for a learner is missing, or the learner has been omitted entirely from the results supplied.
- **Access to scripts** – Centres can request access to marked scripts.

## 4f. Malpractice

Any breach of the regulations for the conduct of examinations and coursework may constitute malpractice (which includes maladministration) and must be reported to OCR as soon as it is detected.

Detailed information on malpractice can be found in the *Suspected Malpractice in Examinations and Assessments: Policies and Procedures* published by JCQ.

# 5 Appendices

## 5a. Overlap with other qualifications

There is a small degree of overlap between the content of these specifications and those for other AS level/A level Sciences.

An example of overlap includes:

**Chemistry A**

- Chromatography.

**Chemistry B (Salters)**

- Polymers and Life: Amino acids, protein structure, DNA, RNA, chromatography, hydrogen bonding.
- Developing a Medicine: Colorimetry.

## 5b. Avoidance of bias

The AS level qualification and subject criteria have been reviewed in order to identify any feature which could disadvantage candidates who share a protected Characteristic as defined by the Equality Act 2010. All reasonable steps have been taken to minimise any such disadvantage.

## 5c. How science works (HSW)

*How science works* (HSW) was conceived as being a wider view of science in context, rather than just straightforward scientific enquiry. It was intended to develop learners as critical and creative thinkers, able to solve problems in a variety of contexts.

Developing ideas and theories to explain the operation of living systems, from the molecular to the ecosystem level, is at the heart of biology. Learners should be aware of the importance that peer review and repeatability have in giving confidence to this evidence.

Learners are expected to understand the variety of sources of data available for critical analysis to provide evidence and the uncertainty involved in its measurement. They should also be able to link that evidence to contexts influenced by culture, politics and ethics.

Understanding *How Science Works* requires an understanding of how scientific evidence can influence ideas and decisions for individuals and society, which is linked to the necessary skills of communication for audience and for purpose with appropriate scientific terminology.

The examples and guidance within the specification are not exhaustive but give a flavour of opportunities for integrating HSW within the course. These references, written in the form HSW1, link to the statements as detailed below:

References in this specification to *How Science Works* (HSW) are to the following statements:

- **HSW1** Use theories, models and ideas to develop scientific explanations
- **HSW2** Use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas
- **HSW3** Use appropriate methodology, including information and communication technology (ICT), to answer scientific questions and solve scientific problems
- **HSW4** Carry out experimental and investigative activities, including appropriate risk management, in a range of contexts
- **HSW5** Analyse and interpret data to provide evidence, recognising correlations and causal relationships
- **HSW6** Evaluate methodology, evidence and data, and resolve conflicting evidence
- **HSW7** Know that scientific knowledge and understanding develops over time
- **HSW8** Communicate information and ideas in appropriate ways using appropriate terminology
- **HSW9** Consider applications and implications of science and evaluate their associated benefits and risks
- **HSW10** Consider ethical issues in the treatment of humans, other organisms and the environment
- **HSW11** Evaluate the role of the scientific community in validating new knowledge and ensuring integrity
- **HSW12** Evaluate the ways in which society uses science to inform decision making.

## 5d. Mathematical requirements

In order to develop their skills, knowledge and understanding in AS Level Biology, learners need to have been taught, and to have acquired competence in, the appropriate areas of mathematics relevant to the subject as indicated in the M0 – M4 table of coverage below.

The assessment of quantitative skills will include at least 10% Level 2 (or above) mathematical skills for biology (see later for a definition of 'Level 2' mathematics).

These skills will be applied in the context of the relevant biology.

All mathematical content will be assessed within the lifetime of the specification. Skills shown in **bold** type in the M0 – M4 coverage table below will only be tested in the full A Level course, not the standalone AS Level course.

The list of examples given in the M0 – M4 coverage table is not exhaustive and is not limited to Level 2 examples. These skills could be developed in other areas of the specification content from those indicated..

### Formulae used in AS Biology

To address biology questions using mathematical skills, learners will need to be able to use and, in some cases, recall formulae and equations. Some of these will seem like pure mathematics, but will be deployed in biological contexts, while others are clearly biological equations, albeit manipulated using standard mathematical, algebraic techniques.

| | Biological | Mathematical |
|---|---|---|
| **Recall** | Magnification<br>Rates<br>R*f*<br>SA : V<br>Genetic biodiversity<br>Cardiac output | All of GCSE (9–1) Maths recall including (but not limited to):<br>• circumference and area of circle<br>• surface area and volume of cuboid<br>• mean<br>• percentage (to include %change, %yield and %error) |
| **Provided** | Simpson's index of diversity | Surface area and volume of cylinder and sphere<br>chi squared<br>*t*-test paired<br>*t*-test unpaired<br>Spearman's rank<br>Standard deviation |

## GCSE (9–1) Mathematical formulae to recall

At AS and A Level Biology we assume knowledge of higher tier GCSE (9–1) Maths content. This includes (but is not limited to) the following list of formulae which learners will need to be able to recall.

Note that learners should be familiar with the convention of using $r$ for radius, $h$ for height, $b$ for base and $l$ for length.

- Circumference of circle

$$Circumference = 2\pi r$$

- Area of circle

$$Area\ of\ circle = \pi r^2$$

- Surface area of cuboid

$$Surface\ area\ of\ cuboid = 2(bh + bl + hl)$$

- Volume of cuboid

$$Volume\ of\ cuboid = hbl$$

- Mean

$$\bar{x} = \frac{\sum x}{n}$$

- Percentage (which can be used to calculate percentage change, percentage yield and percentage error)

$$percentage\ change = \frac{new\ quantity - original\ quantity}{original\ quantity} \times 100$$

$$\%\ yield = \frac{Actual\ Amount}{Theoretical\ Amount} \times 100$$

$$\%\ error\ (uncertainty) = \frac{2 \times absolute\ uncertainty}{quantity\ measured} \times 100\%$$

5

## Biological formulae to recall

The following are the biological formulae learners will need to recall:

- Magnification

$$Magnification = \frac{size\ of\ image}{size\ of\ real\ object}$$

- $R_f$

$$Rf = \frac{distance\ moved\ by\ the\ solute}{distance\ moved\ by\ the\ solvent}$$

- Rates (e.g. enzymatic reactions, breathing (ventilation), transpiration, photosynthesis, respiration, reaction times, diffusion)

$$Rate = \frac{change\ in\ quantity}{time\ taken}$$

- Surface Area to Volume ratio

$$Ratio = \frac{Surface\ Area}{Volume}$$

- Genetic biodiversity

$$proportion\ of\ polymorphic\ gene\ loci = \frac{number\ of\ polymorphic\ gene\ loci}{total\ number\ of\ loci}$$

- Cardiac output as a function of heart rate and stroke volume

$$cardiac\ output = heart\ rate \times stroke\ volume$$

5

## Mathematical formulae that will need to be used but not recalled (provided in the assessments where needed).

- Surface area of a cylinder

$$Surface\ area\ of\ cylinder = 2\pi r(r + l)$$

- Volume of a cylinder

$$Volume\ of\ cylinder = \pi r^2 l$$

- Surface area of a sphere

$$Surface\ area\ of\ sphere = 4\pi r^2$$

- Volume of a sphere

$$Volume\ of\ sphere = \frac{4}{3}\pi r^3$$

- Chi squared

$$\chi^2 = \Sigma\frac{(f_o - f_e)^2}{f_e}$$

- Spearman's Rank Correlation Coefficient

$$r_s = 1 - \frac{6\Sigma d^2}{n(n^2 - 1)}$$

- Standard Deviation

$$s = \sqrt{\frac{\Sigma(x - \overline{x})^2}{n - 1}}$$

- Student's *t*-test – Unpaired

$$t = \frac{|\overline{x}_A - \overline{x}_B|}{\sqrt{\frac{s_A^2}{n_A} + \frac{s_B^2}{n_B}}}$$

- Student's *t*-test – Paired

$$t = \frac{\overline{d}\sqrt{n}}{s_d}$$

Note that critical values tables, or appropriate excerpts from these tables, will be provided in the assessment where needed.

Learners will need to be able to work out which 'degrees of freedom' or 'n' row, and which confidence column(s) is/are relevant to their analysis.

## Biological formulae that will need to be used but not recalled (provided in the assessments where needed):

- Simpson's Index

$$D = 1 - \left(\sum\left(\frac{n}{N}\right)^2\right)$$

## Mathematical skills for biology – M0 – M4 coverage table

| | Mathematical skill to be assessed | Exemplification of the mathematical skill in the context of AS Level Biology (assessment is not limited to the examples below) | Areas of the specification which exemplify the mathematical skill (assessment is not limited to the examples below) |
|---|---|---|---|
| **M0 – Arithmetic and numerical computation** | | | |
| M0.1 | Recognise and make use of appropriate units in calculations | Learners may be tested on their ability to:<br>• convert between units e.g. $mm^3$ to $cm^3$ as part of volumetric calculations<br>• work out the unit for a rate e.g. breathing rate. | 1.1.1(b), 1.1.2(b), 2.1.1(e), 2.1.1(i), 2.1.1(m), 2.1.2(b), 2.1.2(c), 2.1.3(d), 2.2.1(e), 2.2.1(f), 2.2.1(g), 2.2.3(c), 2.2.4(b), 2.2.4(e), 3.1.2(g), 3.1.3(i), 3.2.1(f), 3.2.3(g) |
| M0.2 | Recognise and use expressions in decimal and standard form | Learners may be tested on their ability to:<br>• use an appropriate number of decimal places in calculations, e.g. for a mean<br>• carry out calculations using numbers in standard and ordinary form, e.g. use of magnification<br>• understand standard form when applied to areas such as size of organelles<br>• convert between numbers in standard and ordinary form<br>• understand that significant figures need retaining when making conversions between standard and ordinary form, e.g. 0.0050 mol $dm^{-3}$ is equivalent to $5.0 \times 10^{-3}$ mol $dm^{-3}$. | 2.1.1(e), 2.1.1(i), 2.1.1(m), 2.1.2(b), 2.1.2(c), 2.2.4(b), 2.2.4(e), 3.1.3(h), 3.1.3(i), 3.2.3(g), |
| M0.3 | Use ratios, fractions and percentages | Learners may be tested on their ability to:<br>• calculate percentage yields<br>• calculate surface area to volume ratio<br>• use scales for measuring<br>• represent phenotypic ratios (monohybrid and dihybrid crosses). | 2.1.1(e), 2.1.2(b), 2.1.2(c), 2.1.2(g), 2.1.2(h), 2.1.4(c), 2.2.1(a), 3.1.2(g), 3.1.3(h), 3.2.1(f) |

| | Mathematical skill to be assessed | Exemplification of the mathematical skill in the context of AS Level Biology (assessment is not limited to the examples below) | Areas of the specification which exemplify the mathematical skill (assessment is not limited to the examples below) |
|---|---|---|---|
| M0.4 | Estimate results | Learners may be tested on their ability to:<br>• estimate results to sense check that the calculated values are appropriate. | 2.2.1(e), 2.2.1(f), 2.2.1(g), 3.1.3(h), 3.2.1(f), 3.2.3(g) |
| **M1 – Handling data** | | | |
| M1.1 | Use an appropriate number of significant figures | Learners may be tested on their ability to:<br>• report calculations to an appropriate number of significant figures given raw data quoted to varying numbers of significant figures<br>• understand that calculated results can only be reported to the limits of the least accurate measurement. | 1.1.3(c), 2.1.1(i), 2.1.1(m), 2.1.2(b), 2.1.2(c), 2.1.2(g), 2.1.2(h), 2.2.4(b), 2.2.4(e), 3.1.3(h), 3.1.3(i), 3.2.3(g) |
| M1.2 | Find arithmetic means | Learners may be tested on their ability to:<br>• find the mean of a range of data, e.g. the mean number of stomata in the leaves of a plant. | 2.1.1(i), 2.1.1(m), 2.1.2(b), 2.1.2(c), 2.1.2(g), 2.1.2(h), 2.1.3(d), 2.2.1(e), 2.2.1(f), 2.2.1(g), 2.2.4(b), 2.2.4(e) |
| M1.3 | Construct and interpret frequency tables and diagrams, bar charts and histograms | Learners may be tested on their ability to:<br>• represent a range of data in a table with clear headings, units and consistent decimal places<br>• interpret data from a variety of tables, e.g. data relating to organ function<br>• plot a range of data in an appropriate format, e.g. enzyme activity over time represented on a graph<br>• interpret data for a variety of graphs, e.g. explain electrocardiogram traces. | 2.1.2(c), 2.1.2(g), 2.1.2(h), 2.1.3(d), 2.2.1(e), 2.2.1(f), 2.2.1(g), 2.2.4(e), 3.1.2(g), 3.2.1(g), 3.3.1(f) |

| | Mathematical skill to be assessed | Exemplification of the mathematical skill in the context of AS Level Biology (assessment is not limited to the examples below) | Areas of the specification which exemplify the mathematical skill (assessment is not limited to the examples below) |
|---|---|---|---|
| M1.4 | Understand simple probability | Learners may be tested on their ability to:<br>• use the terms probability and chance appropriately<br>• understand the probability associated with genetic inheritance. | 3.1.2(g) |
| M1.5 | Understand the principles of sampling as applied to scientific data | Learners may be tested on their ability to:<br>• analyse random data collected by an appropriate means, e.g. use Simpson's index of diversity to calculate the biodiversity of a habitat. | 2.1.1(e), 3.3.1(f), 3.3.2(f) |
| M1.6 | Understand the terms mean, median and mode | Learners may be tested on their ability to:<br>• calculate or compare the mean, median and mode of a set of data, e.g. height/mass/ size of a group of organisms. | 2.1.2(b), 2.1.2(c), 2.2.4(e), 3.1.2(g) |
| M1.7 | Use a scatter diagram to identify a correlation between two variables | Learners may be tested on their ability to:<br>• interpret a scattergram, e.g. the effect of life style factors on health. | 3.2.1(g), 3.3.1(f) |
| M1.8 | Make order of magnitude calculations | Learners may be tested on their ability to:<br>• use and manipulate the magnification formula:<br>• $\text{magnification} = \frac{\text{size of image}}{\text{size of real object}}$ | 2.1.1(d), 2.1.1(g), 2.1.1(i), 2.2.4(b) |

| | Mathematical skill to be assessed | Exemplification of the mathematical skill in the context of AS Level Biology (assessment is not limited to the examples below) | Areas of the specification which exemplify the mathematical skill (assessment is not limited to the examples below) |
|---|---|---|---|
| M1.9 | Select and use a statistical test | Learners may be tested on their ability to select and use:<br>• the chi squared ($X^2$) test to test the significance of the difference between observed and expected results<br>• the Student's *t*-test<br>• the Spearman's rank correlation coefficient. | |
| M1.10 | Understand measures of dispersion, including standard deviation and range | Learners may be tested on their ability to:<br>• calculate the standard deviation<br>• understand why standard deviation might be a more useful measure of dispersion for a given set of data e.g. where there is an outlying result. | 2.1.1(e), 2.2.1(g) |
| M1.11 | Identify uncertainties in measurements and use simple techniques to determine uncertainty when data are combined | Learners may be tested on their ability to:<br>• calculate percentage error where there are uncertainties in measurement. | 1.1.4(d), 2.1.3(d), 2.2.1(e), 2.2.1(f), 2.2.1(g), 2.2.4(e) |
| **M2 – Algebra** | | | |
| M2.1 | Understand and use the symbols: $=, <, \ll, \gg, >, \propto, \sim$ | No exemplification required. | 2.2.4(b) |
| M2.2 | Change the subject of an equation | Learners may be tested on their ability to:<br>• use and manipulate equations, e.g. magnification. | 2.1.1(i), 2.2.3(c), 3.1.3(i) |
| M2.3 | Substitute numerical values into algebraic equations using appropriate units for physical quantities | Learners may be tested on their ability to:<br>• use a given equation e.g. Simpson's-index of diversity $D = 1 - (\sum(n/N)^2)$. | 2.2.1(e), 2.2.1(f), 2.2.3(c) |

| | Mathematical skill to be assessed | Exemplification of the mathematical skill in the context of AS Level Biology (assessment is not limited to the examples below) | Areas of the specification which exemplify the mathematical skill (assessment is not limited to the examples below) |
|---|---|---|---|
| M2.4 | Solve algebraic equations | Learners may be tested on their ability to:<br>• solve equations in a biological context, e.g. $\text{cardiac output} = \text{stroke volume} \times \text{heart rate}$ | 2.2.1(e), 2.2.1(f), 2.2.3(c), 3.1.3(i) |
| **M3 – Graphs** | | | |
| M3.1 | Translate information between graphical, numerical and algebraic forms | Learners may be tested on their ability to:<br>• understand that data may be presented in a number of formats and be able to use these data, e.g. dissociation curves. | 1.2.1(g), 2.1.1(m), 2.1.2(b), 2.1.2(c), 2.1.2(g), 2.1.2(h), 2.1.3(d), 2.2.1(e), 2.2.1(f), 2.2.1(g), 2.2.1(h), 2.2.4(e), 3.2.1(g), 3.3.1(f) |
| M3.2 | Plot two variables from experimental or other data | Learners may be tested on their ability to:<br>• select an appropriate format for presenting data, bar charts, histograms, graphs and scattergrams. | 1.1.3(d), 2.1.1(m), 2.1.2(c), 2.1.2(g), 2.1.2(h), 2.1.3(d), 2.2.1(e), 2.2.1(f), 2.2.1(g), 2.2.4(e) |
| M3.3 | Understand that $y = mx + c$ represents a linear relationship | Learners may be tested on their ability to:<br>• predict/sketch the shape of a graph with a linear relationship, e.g. the effect of substrate concentration on the rate of an enzyme-controlled reaction with excess enzyme. | 1.1.3(d), 2.1.1(m), 2.1.3(d), 2.2.4(e) |
| M3.5 | Calculate rate of change from a graph showing a linear relationship | Learners may be tested on their ability to:<br>• calculate a rate from a graph, e.g. rate of transpiration. | 1.1.3(d), 2.1.1(m), 2.1.3(d), 2.2.4(e), 3.2.1(g) |
| M3.6 | Draw and use the slope of a tangent to a curve as a measure of rate of change | Learners may be tested on their ability to:<br>• use this method to measure the gradient of a point on a curve, e.g. amount of product formed plotted against time when the concentration of enzyme is fixed. | 1.1.3(d), 2.1.1(m), 2.1.3(d), 2.2.4(e), 3.2.1(g) |

| | Mathematical skill to be assessed | Exemplification of the mathematical skill in the context of AS Level Biology (assessment is not limited to the examples below) | Areas of the specification which exemplify the mathematical skill (assessment is not limited to the examples below) |
|---|---|---|---|
| **M4 – Geometry and trigonometry** | | | |
| M4.1 | Calculate the circumferences, surface areas and volumes of regular shapes | Learners may be tested on their ability to:<br>• calculate the circumference and area of a circle<br>• calculate the surface area and volume of rectangular prisms, of cylindrical prisms and of spheres<br>• e.g. calculate the surface area or volume of a cell. | 2.1.1(e), 2.1.1(i), 2.2.1(a), 2.2.4(e), 3.2.3(g) |

## Definition of Level 2 mathematics

Within AS Level in Biology, 10% of the marks available within written examinations will be for assessment of mathematics (in the context of biology) at a Level 2 standard, or higher. Lower level mathematical skills will still be assessed within examination papers but will not count within the 10% weighting for biology.

The following will be counted as Level 2 (or higher) mathematics:

- application and understanding requiring choice of data or equation to be used
- problem solving involving use of mathematics from different areas of maths and decisions about direction to proceed
- questions involving use of A level mathematical content (as of 2012), e.g. use of logarithmic equations.

The following will <u>not</u> be counted as Level 2 mathematics:

- simple substitution with little choice of equation or data
- structured question formats using GCSE mathematics (based on 2012 GCSE mathematics content).

Additional guidance on the assessment of mathematics within biology is available on the OCR website as a separate resource, the Maths Skills Handbook.

## 5e. Health and Safety

In UK law, health and safety is primarily the responsibility of the employer. In a school or college the employer could be a local education authority, the governing body or board of trustees. Employees (teachers/lecturers, technicians etc), have a legal duty to cooperate with their employer on health and safety matters. Various regulations, but especially the COSHH Regulations 2002 (as amended) and the Management of Health and Safety at Work Regulations 1999, 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 carry out a risk assessment. A useful summary of the requirements for risk assessment in school or college science can be found at **http://www.ase.org.uk/resources/health-and-safety-resources/risk-assessments**

For members, the CLEAPSS® guide, *PS90*, *Making and recording risk assessments in school science*[1] offers appropriate advice.

Most education employers have adopted nationally available publications as the basis for their Model Risk Assessments.

Where an employer has adopted 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 the skills of the candidates were insufficient to attempt particular activities safely. The significant findings of such risk assessment should then be recorded in a "*point of use text* ", 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 for each practical activity, although a minority of employers may require this.

Where project work or investigations, sometimes linked to work-related activities, are included in specifications this 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 CLEAPSS®.

[1] These, and other CLEAPSS® publications, are on the CLEAPSS® Science Publications website **www.cleapss.org.uk**. Note that CLEAPSS® publications are only available to members. For more information about CLEAPSS® go to **www.cleapss.org.uk**.

## Summary of updates

| Date | Version | Section | Title of section | Change |
|---|---|---|---|---|
| December 2017 | 2 | Multiple | | Changes to generic wording and OCR website links throughout specification. No changes made to any assessment requirements. |
| April 2018 | 2.1 | Front cover | Disclaimer | Addition of Disclaimer |
| January 2020 | 2.2 | 1d | How do I find out more information? | Delete reference to OCR Social Community and replace with link to Online Support Centre |
| | | 4d | Post-results services | Delete reference to Enquiries About Results and replace with review of results |
| | | | | Update to specification covers to meet digital accessibility standards |
| April 2023 | 2.3 | 3c | Total qualification time | Update to include total qualification time and guided learning hours to comply with QiW regulations |
| February 2024 | 2.4 | 3d, 3e | Qualification availability, Language | Inclusion of disclaimer regarding availability and language |
| | | 4a | Pre-assessment | Update to include resilience guidance |
| | | Checklist | | Inclusion of Teach Cambridge |

# YOUR CHECKLIST

*Our aim is to provide you with all the information and support you need to deliver our specifications.*

- ☐ Bookmark OCR website for all the latest information and news on AS and A Level Biology B (Advancing Biology)
- ☐ Sign up for Teach Cambridge: our personalised and secure website that provides teachers with access to all planning, teaching and assessment support materials
- ☐ Be among the first to hear about support materials and resources as they become available – register for Biology updates
- ☐ Find out about our professional development
- ☐ View our range of skills guides for use across subjects and qualifications
- ☐ Discover our new online past paper service
- ☐ Learn more about Active Results
- ☐ Visit our Online Support Centre

## Download high-quality, exciting and innovative AS and A Level Biology resources from ocr.org.uk/alevelbiologyb

Free resources and support for our AS Level Biology qualification, developed through collaboration between our Biology Subject Advisors, teachers and other subject experts, are available from our website. You can also contact our Biology Subject Advisors for specialist advice, guidance and support, giving you individual service and assistance whenever you need it.


**Contact the team at:**

**01223 553998**

**scienceGCE@ocr.org.uk**

**@OCR_science**


To stay up to date with all the relevant news about our qualifications, register for email updates at **ocr.org.uk/updates**

Visit our Online Support Centre at **support.ocr.org.uk**

follow us on

facebook.com/ocrexams

linkedin.com/company/ocr

@OCRexams

youtube.com/ocrexams

CAMBRIDGE UNIVERSITY PRESS & ASSESSMENT