

**Specification**

**A LEVEL**

# **BIOLOGY A**

**OCR Level 3 Advanced Subsidiary GCE  
in Biology A**

**H020**

For first assessment in 2016

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## ***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](mailto: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](http://ocr.org.uk)) and these may differ from printed versions.

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## Introducing...

### AS Level Biology A (from September 2015)

This specification allows teachers to adopt a flexible approach to the delivery of AS Level Biology. The course has been designed to enable centres to deliver the content modules (Modules 2–4) using the framework provided, or to design a customised course. Practical work undertaken to support teaching of the content will serve to cover the requirements of the practical skills module (Module 1), which is assessed in the written examinations.

The specification is divided into topics, each containing different key concepts of biology. Throughout the specification, cross-references indicate the relevance of individual learning outcomes to the mathematical criteria that are embedded in the assessments.

This specification incorporates the Ofqual GCE Subject Level Conditions and Requirements for Biology.

#### 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**
- [science@ocr.org.uk](mailto:science@ocr.org.uk)
- [@OCR\\_science](https://twitter.com/OCR_science)



## Teaching and learning resources

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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](https://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](https://ocr.org.uk/activeresults)

## Professional Development

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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 A 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](https://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](https://ocr.org.uk/updates).

# 1 Why choose an OCR AS Level in Biology A?

## 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 A 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 AS 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 A is QN: 601/4261/3.

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## 1b. Why choose an OCR AS Level in Biology A?

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) (a new course for OCR)** – 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).

Our new AS Level in Biology A qualification builds on our existing popular course. We've based the redevelopment of our AS sciences on an understanding of what works well in centres large and small and have updated areas of content and assessment where stakeholders have identified that improvements could be made. 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 are an evolution of our legacy offering and will be familiar to centres already following our courses, but are 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 A 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 AS Level in Biology A specification is designed with a content-led approach and provides a flexible way of teaching. The specification:

- retains and refreshes the popular topics from the legacy OCR Biology qualification (H021)
- is laid out clearly in a series of teaching modules with Additional guidance added where required to clarify assessment requirements
- is co-teachable with the A level
- embeds practical requirements within the teaching modules. Whilst the Practical Endorsement is not part of the AS Level in Biology A opportunities for carrying out activities that would count towards the Practical

Endorsement are indicated throughout this specification, in the Additional guidance column, by use of **PAG**, refer to the A level specification, Section 5g, for Practical Endorsement requirements

- exemplifies the mathematical requirements of the course (see Section 5d)
- highlights opportunities for the introduction of key mathematical requirements (see Section 5c and the Additional guidance column for each module) into your teaching
- identifies, within the Additional guidance column 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 Monthly Newsletter*
- Practical Skills Handbook
- Maths Skills Handbook
- Biological Drawing skills handbook.

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

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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](http://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 monthly newsletter. To receive the newsletter sign up at: <https://www.ocr.org.uk/qualifications/email-updates/>

You can contact the Science Subject Advisors: [science@ocr.org.uk](mailto:science@ocr.org.uk), 01223 553998.

Visit our Online Support Centre at [support.ocr.org.uk](http://support.ocr.org.uk)

Check what CPD events are available: [www.cpdhub.ocr.org.uk](http://www.cpdhub.ocr.org.uk)

Follow us on Twitter: [@ocr\\_science](https://twitter.com/ocr_science)

## 2 The specification overview

### 2a. Overview of AS Level in Biology A (H020)

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

Content Overview	Assessment Overview	
<p>Content is split into four teaching modules:</p> <ul style="list-style-type: none"><li>Module 1 – Development of practical skills in biology</li><li>Module 2 – Foundations in biology</li><li>Module 3 – Exchange and transport</li><li>Module 4 – Biodiversity, evolution and disease</li></ul> <p>Both components assess content from all four modules.</p>	<p>Breadth in biology (01)</p> <p>70 Marks</p> <p>1 hour 30 minutes written paper</p>	<p><b>50%</b></p> <p>of total A level</p>
	<p>Depth in biology (02)</p> <p>70 Marks</p> <p>1 hour 30 minutes written paper</p>	<p><b>50%</b></p> <p>of total A level</p>

Both components include synoptic assessment

## 2b. Content of AS Level in Biology A (H020)

The AS Level in Biology A specification content is divided into four teaching modules and each module is further divided into key topics. Each module is introduced with a summary of the biology it contains and each topic is also introduced with a short summary text. 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 5c) are included in the guidance to highlight opportunities to encourage a wider understanding of science.

The mathematical requirements in section 5d is also referenced by the prefix *M* to link the mathematical skills required for AS Level in Biology to examples of biology 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 A qualification. Learners studying the A level study modules 1 to 4 and then continue with the A level only modules 5 and 6 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 – Foundations in biology

- 2.1.1 Cell structure
- 2.1.2 Biological molecules
- 2.1.3 Nucleotides and nucleic acids
- 2.1.4 Enzymes
- 2.1.5 Biological membranes
- 2.1.6 Cell division, cell diversity and cellular organisation

### Module 3 – Exchange and transport

- 3.1.1 Exchange surfaces
- 3.1.2 Transport in animals
- 3.1.3 Transport in plants

### Module 4 – Biodiversity, evolution and disease

- 4.1.1 Communicable diseases, disease prevention and the immune system
- 4.2.1 Biodiversity
- 4.2.2 Classification and evolution.



## 2c. Content of modules 1 to 4

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

##### 1.1.2 Implementing

Learning outcomes	Additional guidance
<i>Learners should be able to demonstrate and apply their knowledge and understanding of:</i>	
(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. HSW4
(b) appropriate units for measurements	MO.1
(c) presenting observations and data in an appropriate format.	HSW8

### 1.1.3 Analysis

Learning outcomes	Additional guidance
<i>Learners should be able to demonstrate and apply their knowledge and understanding of:</i>	
(a) processing, analysing and interpreting qualitative and quantitative experimental results	Including reaching valid conclusions, where appropriate. HSW5
(b) use of appropriate mathematical skills for analysis of quantitative data	Refer to Section 5d for a list of mathematical skills that learners should have acquired competence in as part of their course. 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
<i>Learners should be able to demonstrate and apply their knowledge and understanding of:</i>	
(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	M1.11
(e) the refining of experimental design by suggestion of improvements to the procedures and apparatus.	HSW3

## Module 2: Foundations in biology

All living organisms have similarities in cellular structure, biochemistry and function. An understanding of these similarities is fundamental to the study of the subject.

This module gives learners the opportunity to use microscopy to study the cell structure of a variety of organisms. Biologically important molecules such as carbohydrates, proteins, water and nucleic acids are studied with respect to their structure and function. The structure and mode of action of enzymes in catalysing biochemical reactions is studied.

Membranes form barriers within, and at the surface of, cells. This module also considers the way in which the structure of membranes relates to the different methods by which molecules enter and leave cells and organelles.

The division and subsequent specialisation of cells is studied, together with the potential for the therapeutic use of stem cells.

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

### 2.1 Foundations in biology

#### 2.1.1 Cell structure

Biology is the study of living organisms. Every living organism is made up of one or more cells, therefore understanding the structure and function of the cell is a fundamental concept in the study of biology. Since Robert Hooke coined the phrase 'cells' in 1665, careful

observation using microscopes has revealed details of cell structure and ultrastructure and provided evidence to support hypotheses regarding the roles of cells and their organelles.

Learning outcomes	Additional guidance
<i>Learners should be able to demonstrate and apply their knowledge and understanding of:</i>	
(a) the use of microscopy to observe and investigate different types of cell and cell structure in a range of eukaryotic organisms	To include an appreciation of the images produced by a range of microscopes: light microscope, transmission electron microscope and scanning electron microscope.  HSW1, HSW7
(b) the preparation and examination of microscope slides for use in light microscopy	Including the use of an eyepiece graticule and stage micrometer. <b>PAG1</b> HSW4
(c) the use of staining in light microscopy	To include the use of differential staining to identify different cellular components and cell types. <b>PAG1</b> HSW4, HSW5
(d) the representation of cell structure as seen under the light microscope using drawings and annotated diagrams of whole cells or cells in sections of tissue	<b>PAG1</b>

- (e) the use and manipulation of the magnification formula

$$\text{magnification} = \frac{\text{size of image}}{\text{size of real object}}$$

*M0.1, M0.2, M0.3, M1.1, M1.8, M2.2, M2.3, M2.4*

- (f) the difference between magnification and resolution

To include an appreciation of the differences in resolution and magnification that can be achieved by a light microscope, a transmission electron microscope and a scanning electron microscope.

Learners are **not** required to recall exact resolutions or magnification numbers for each of the listed microscopes.

*M0.2, M0.3*  
HSW7, HSW8

- (g) the ultrastructure of eukaryotic cells and the functions of the different cellular components

To include the following cellular components and an outline of their functions: nucleus, nucleolus, nuclear envelope, rough and smooth endoplasmic reticulum (ER), Golgi apparatus, ribosomes, mitochondria, lysosomes, chloroplasts, plasma membrane, centrioles, cell wall, flagella and cilia.

*M0.2*

- (h) photomicrographs of cellular components in a range of eukaryotic cells

To include interpretation of transmission and scanning electron microscope images.

- (i) the interrelationship between the organelles involved in the production and secretion of proteins

- (j) the importance of the cytoskeleton

To include providing mechanical strength to cells, aiding transport within cells and enabling cell movement.

HSW2

- (k) the similarities and differences in the structure and ultrastructure of prokaryotic and eukaryotic cells.

**PAG1**



### 2.1.2 Biological molecules

The cells of all living organisms are composed of biological molecules. Proteins, carbohydrates and lipids are three of the key groups of biological

macromolecules that are essential for life. A study of the structure of these macromolecules allows a better understanding of their functions in living organisms.

Learning outcomes	Additional guidance
<i>Learners should be able to demonstrate and apply their knowledge and understanding of:</i>	Where appropriate, this section should include diagrams to represent molecular structure and bonding.
(a) how hydrogen bonding occurs between water molecules, and relate this, and other properties of water, to the roles of water for living organisms	To include roles that relate to the properties of water; solvent, transport medium, coolant and as a habitat. <b>AND</b> roles illustrated using examples of prokaryotes and eukaryotes.  Learners should be able to apply their knowledge and understanding in the context of prokaryotes and eukaryotes.  HSW2, HSW8
(b) the concept of monomers and polymers and the importance of condensation and hydrolysis reactions in a range of biological molecules	
(c) the chemical elements that make up biological molecules	To include: C, H and O for carbohydrates C, H and O for lipids C, H, O, N and S for proteins C, H, O, N and P for nucleic acids.
(d) the ring structure and properties of glucose as an example of a hexose monosaccharide and the structure of ribose as an example of a pentose monosaccharide	To include the structural difference between an $\alpha$ - and a $\beta$ -glucose molecule <b>AND</b> the difference between a hexose and a pentose monosaccharide.
(e) the synthesis and breakdown of a disaccharide and polysaccharide by the formation and breakage of glycosidic bonds	To include the disaccharides sucrose, lactose and maltose.
(f) the structure of starch (amylose and amylopectin), glycogen and cellulose molecules	HSW8
(g) how the structures and properties of glucose, starch, glycogen and cellulose molecules relate to their functions in living organisms	HSW2, HSW8

Learning outcomes	Additional guidance
(h) the structure of a triglyceride and a phospholipid as examples of macromolecules	To include the structure of saturated and unsaturated fatty acids.
(i) the synthesis and breakdown of triglycerides by the formation and breakage of ester bonds between fatty acids and glycerol	
(j) how the properties of triglyceride, phospholipid and cholesterol molecules relate to their functions in living organisms	<p>To include hydrophobic and hydrophilic regions and energy content.</p> <p>Learners should be able to apply their knowledge and understanding in the context of prokaryotes and eukaryotes.</p> <p>HSW2, HSW8</p>
(k) the general structure of an amino acid	
(l) the synthesis and breakdown of dipeptides and polypeptides, by the formation and breakage of peptide bonds	
(m) the levels of protein structure	<p>To include primary, secondary, tertiary and quaternary structure</p> <p><b>AND</b></p> <p>hydrogen bonding, hydrophobic and hydrophilic interactions, disulfide bonds and ionic bonds.</p> <p>HSW8</p>
(n) the structure and function of globular proteins including a conjugated protein	<p>To include haemoglobin as an example of a conjugated protein (globular protein with a prosthetic group), a named enzyme and insulin.</p> <p><b>PAG10</b></p>
(o) the properties and functions of fibrous proteins	<p>To include collagen, keratin and elastin (no details of structure are required).</p>
(p) the key inorganic ions that are involved in biological processes	<p>To include the following:</p> <p>calcium ions (<math>\text{Ca}^{2+}</math>), sodium ions (<math>\text{Na}^+</math>), potassium ions (<math>\text{K}^+</math>), hydrogen ions (<math>\text{H}^+</math>), ammonium ions (<math>\text{NH}_4^+</math>)</p> <p>nitrate (<math>\text{NO}_3^-</math>), hydrogencarbonate (<math>\text{HCO}_3^-</math>), chloride (<math>\text{Cl}^-</math>), phosphate (<math>\text{PO}_4^{3-}</math>), hydroxide (<math>\text{OH}^-</math>).</p> <p>Learners should be able to recognise the symbols for these ions.</p>

<p>(q) how to carry out and interpret the results of the following chemical tests:</p> <ul style="list-style-type: none"> <li>• biuret test for proteins</li> <li>• Benedict's test for reducing and non-reducing sugars</li> <li>• iodine test for starch</li> <li>• emulsion test for lipids</li> </ul>	<p><b>PAG9</b> HSW3, HSW4, HSW5</p>
<p>(r) quantitative methods to determine the concentration of a chemical substance in a solution</p>	<p>To include colorimetry. <b>PAG5</b> HSW3, HSW4, HSW5</p>
<p>(s) (i) the principles and uses of paper and thin layer chromatography to separate biological molecules / compounds</p> <p>(ii) practical investigations to analyse biological solutions using paper or thin layer chromatography.</p>	<p>To include calculation of <math>R_f</math> values.</p> $R_f = \frac{\text{distance moved by the solute}}{\text{distance moved by the solvent}}$ <p>Learners should be able to apply their knowledge and understanding in the context of separating proteins, carbohydrates, vitamins and nucleic acids.</p> <p><i>M0.1, M0.2, M1.1, M1.3, M2.2, M2.3, M2.4</i> <b>PAG6</b> HSW2, HSW3, HSW4</p>

### 2.1.3 Nucleotides and nucleic acids

Nucleic acids are essential to heredity in living organisms. Understanding the structure of nucleotides and nucleic acids allows an understanding of their roles

in the storage and use of genetic information and cell metabolism.

Learning outcomes	Additional guidance
<p><i>Learners should be able to demonstrate and apply their knowledge and understanding of:</i></p>	
<p>(a) the structure of a nucleotide as the monomer from which nucleic acids are made</p>	<p>To include the differences between RNA and DNA nucleotides, the identification of the purines and pyrimidines, the type of pentose sugar.</p> <p><b>PAG10</b></p>
<p>(b) the synthesis and breakdown of polynucleotides by the formation and breakage of phosphodiester bonds</p>	
<p>(c) the structure of ADP and ATP as phosphorylated nucleotides</p>	<p>Comprising a pentose sugar (ribose), a nitrogenous base (adenine) and inorganic phosphates.</p>

- (d) (i) the structure of DNA (deoxyribonucleic acid)
- (ii) practical investigations into the purification of DNA by precipitation
- (e) semi-conservative DNA replication
- (f) the nature of the genetic code
- (g) transcription and translation of genes resulting in the synthesis of polypeptides.
- To include how hydrogen bonding between complementary base pairs (A to T, G to C) on two antiparallel DNA polynucleotides leads to the formation of a DNA molecule, and how the twisting of DNA produces its 'double-helix' shape.  
**PAG9**  
HSW3, HSW4
- 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.
- At AS Level learners are **not** required to distinguish between different types of mutation.
- HSW8
- To include the triplet, non-overlapping, degenerate and universal nature of the code and how a gene determines the sequence of amino acids in a polypeptide (the primary structure of a protein).
- To include, the roles of RNA polymerase, messenger (m)RNA, transfer (t)RNA, ribosomal (r)RNA.
- HSW8

### 2.1.4 Enzymes

Metabolism in living organisms relies upon enzyme-controlled reactions. Knowledge of how enzymes function and the factors that affect enzyme action has

improved our understanding of biological processes and increased our use of enzymes in industry.

Learning outcomes	Additional guidance
<i>Learners should be able to demonstrate and apply their knowledge and understanding of:</i>	
(a) the role of enzymes in catalysing reactions that affect metabolism at a cellular and whole organism level	To include the idea that enzymes affect both structure and function.
(b) the role of enzymes in catalysing both intracellular and extracellular reactions	To include catalase as an example of an enzyme that catalyses intracellular reactions and amylase as an example of an enzyme that catalyses extracellular reactions.



- (c) the mechanism of enzyme action
- To include the tertiary structure, specificity, active site, lock and key hypothesis, induced-fit hypothesis, enzyme-substrate complex, enzyme-product complex, product formation and lowering of activation energy.
- HSW1, HSW8
- (d) (i) the effects of pH, temperature, enzyme concentration and substrate concentration on enzyme activity
- To include reference to the temperature coefficient ( $Q_{10}$ ).
- $$Q_{10} = \frac{R_2}{R_1}$$
- (ii) practical investigations into the effects of pH, temperature, enzyme concentration and substrate concentration on enzyme activity
- An opportunity for serial dilutions  
*M0.1, M0.2, M0.3, M1.1, M1.3, M1.11, M3.1, M3.2, M3.3, M3.5, M3.6*  
**PAG4**  
 HSW1, HSW2, HSW4, HSW5, HSW6, HSW8
- (e) the need for coenzymes and cofactors in some enzyme-controlled reactions
- To include the chloride ion as a cofactor for amylase and vitamins as a source of coenzymes.  
**PAG4**
- (f) the effects of inhibitors on the rate of enzyme-controlled reactions.
- To include competitive and non-competitive, reversible and non-reversible inhibitors, and the role of end-product inhibition.
- M0.1, M0.2, M0.3, M1.1, M1.3, M1.11, M3.1, M3.2, M3.3, M3.5, M3.6*  
**PAG4**  
 HSW1, HSW2, HSW4, HSW5, HSW6, HSW8

## 2.1.5 Biological membranes

Membranes are fundamental to the cell theory. The structure of the plasma membrane allows cells to communicate with each other. Understanding this ability to communicate is important as scientists increasingly make use of membrane-bound receptors as sites for the action of medicinal drugs.

Understanding how different substances enter cells is also crucial to the development of mechanisms for the administration of drugs.

Learning outcomes	Additional guidance
<i>Learners should be able to demonstrate and apply their knowledge and understanding of:</i>	
(a) the roles of membranes within cells and at the surface of cells	<p>To include the roles of membranes as:</p> <ul style="list-style-type: none"> <li>partially permeable barriers between the cell and its environment, between organelles and the cytoplasm and within organelles</li> <li>sites of chemical reactions</li> <li>sites of cell communication (cell signalling).</li> </ul>
(b) the fluid mosaic model of membrane structure and the roles of its components	<p>To include phospholipids, cholesterol, glycolipids, proteins and glycoproteins</p> <p><b>AND</b></p> <p>the role of membrane-bound receptors as sites where hormones and drugs can bind.</p> <p><i>M0.2</i> <i>HSW1</i></p>
(c) (i) factors affecting membrane structure and permeability (ii) practical investigations into factors affecting membrane structure and permeability	<p>To include the effects of temperature and solvents.</p> <p><i>M0.1, M0.2, M1.1, M1.2, M1.3, M1.6, M1.11, M3.1, M3.2, M3.3, M3.5, M3.6</i></p> <p><b>PAG8</b> <i>HSW1, HSW2, HSW3, HSW4, HSW5, HSW6</i></p>
(d) (i) the movement of molecules across membranes (ii) practical investigations into the factors affecting diffusion rates in model cells	<p>To include diffusion and facilitated diffusion as passive methods</p> <p><b>AND</b></p> <p>active transport, endocytosis and exocytosis as processes requiring adenosine triphosphate (ATP) as an immediate source of energy.</p> <p><i>M0.1, M0.2, M0.3, M1.1, M1.2, M1.3, M1.6, M1.11, M2.1, M3.1, M3.2, M3.3, M3.5, M3.6, M4.1</i></p> <p><b>PAG8</b> <i>HSW1, HSW2, HSW3, HSW4, HSW5, HSW6</i></p>

- (e) (i) the movement of water across membranes by osmosis and the effects that solutions of different water potential can have on plant and animal cells
- (ii) practical investigations into the effects of solutions of different water potential on plant and animal cells.
- Osmosis to be explained in terms of a water potential gradient across a partially-permeable membrane.
- M0.1, M0.2, M0.3, M1.1, M1.2, M1.3, M1.6, M1.10, M1.11, M2.1, M3.1, M3.2, M4.1*
- PAG8**
- HSW1, HSW2, HSW3, HSW4, HSW5, HSW6

### 2.1.6 Cell division, cell diversity and cellular organisation

During the cell cycle, genetic information is copied and passed to daughter cells. Microscopes can be used to view the different stages of the cycle.

In multicellular organisms, stem cells are modified to produce many different types of specialised cell.

Understanding how stem cells can be modified has huge potential in medicine.

To understand how a whole organism functions, it is essential to appreciate the importance of cooperation between cells, tissues, organs and organ systems.

Learning outcomes	Additional guidance
<i>Learners should be able to demonstrate and apply their knowledge and understanding of:</i>	
(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 cells.
	HSW8
(b) how the cell cycle is regulated	To include an outline of the use of checkpoints to control the cycle.
(c) the main stages of mitosis	To include the changes in the nuclear envelope, chromosomes, chromatids, centromere, centrioles, spindle fibres and cell membrane.
	HSW8
(d) sections of plant tissue showing the cell cycle and stages of mitosis	To include the examination of stained sections and squashes of plant tissue and the production of labelled diagrams to show the stages observed.
	<b>PAG1</b>
(e) the significance of mitosis in life cycles	To include growth, tissue repair and asexual reproduction in plants, animals and fungi.
	HSW2
(f) the significance of meiosis in life cycles	To include the production of haploid cells and genetic variation by independent assortment and crossing over.
	HSW2, HSW5

- (g) the main stages of meiosis
- To include 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) and the term *homologous chromosomes*.  
**PAG1**  
HSW8
- (h) how cells of multicellular organisms are specialised for particular functions
- To include erythrocytes, neutrophils, squamous and ciliated epithelial cells, sperm cells, palisade cells, root hair cells and guard cells.  
**PAG1**
- (i) the organisation of cells into tissues, organs and organ systems
- To include squamous and ciliated epithelia, cartilage, muscle, xylem and phloem as examples of tissues.
- (j) the features and differentiation of stem cells
- To include stem cells as a renewing source of undifferentiated cells.
- (k) the production of erythrocytes and neutrophils as examples of distinct, differentiated cells derived from a common stem cell in bone marrow
- (l) the production of xylem vessels and phloem sieve tubes as examples of distinct, differentiated outcomes derived from a common stem cell in meristems
- (m) the potential uses of stem cells in research and medicine.
- To include the repair of damaged tissues, the treatment of neurological conditions and research into developmental biology.
- Learners are **not** required to recall specific neurological conditions.
- HSW2, HSW5, HSW6, HSW7, HSW9, HSW10, HSW11, HSW12

## Module 3: Exchange and transport

In this module, learners study the structure and function of gas exchange and transport systems in a range of animals and in terrestrial plants.

The significance of surface area to volume ratio in determining the need for ventilation, gas exchange and transport systems in multicellular organisms is emphasised. The examples of terrestrial green plants

and a range of animal phyla are used to illustrate the principle.

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

### 3.1 Exchange and transport

#### 3.1.1 Exchange surfaces

As animals become larger and more active, ventilation and gas exchange systems become essential to supply oxygen to, and remove carbon dioxide from, their bodies.

Ventilation and gas exchange systems in mammals, bony fish and insects are used as examples of the properties and functions of exchange surfaces in animals.

Learning outcomes	Additional guidance
<i>Learners should be able to demonstrate and apply their knowledge and understanding of:</i>	
(a) the need for specialised exchange surfaces	<p>To include surface area to volume ratio (SA:V), metabolic activity, single-celled and multicellular organisms.</p> $\text{Ratio} = \frac{\text{Surface Area}}{\text{Volume}}$ <p>M0.1, M0.3, M0.4, M1.1, M2.1, M4.1 HSW1, HSW3, HSW5, HSW8</p>
(b) the features of an efficient exchange surface	<p>To include:</p> <ul style="list-style-type: none"> <li>increased surface area – root hair cells</li> <li>thin layer – alveoli</li> <li>good blood supply/ventilation to maintain gradient – gills/alveolus.</li> </ul>
(c) the structures and functions of the components of the mammalian gaseous exchange system	<p>To include the distribution and functions of cartilage, ciliated epithelium, goblet cells, smooth muscle and elastic fibres in the trachea, bronchi, bronchioles and alveoli.</p> <p><b>PAG1</b> HSW8</p>
(d) the mechanism of ventilation in mammals	<p>To include the function of the rib cage, intercostal muscles (internal and external) and diaphragm.</p> <p>HSW8</p>

- (e) the relationship between vital capacity, tidal volume, breathing rate and oxygen uptake

To include analysis and interpretation of primary and secondary data e.g. from a data logger or spirometer.

*M0.1, M0.2, M0.4, M1.3*

**PAG10**

HSW2, HSW3, HSW4, HSW 5, HSW6

- (f) the mechanisms of ventilation and gas exchange in bony fish and insects

To include:

- bony fish – changes in volume of the buccal cavity and the functions of the operculum, gill filaments and gill lamellae (gill plates); countercurrent flow
- insects – spiracles, trachea, thoracic and abdominal movement to change body volume, exchange with tracheal fluid.

HSW8

- (g) the dissection, examination and drawing of the gaseous exchange system of a bony fish and/or insect trachea

**PAG2**

- (h) the examination of microscope slides to show the histology of exchange surfaces.

**PAG1**

### 3.1.2 Transport in animals

As animals become larger and more active, transport systems become essential to supply nutrients to, and remove waste from, individual cells.

Controlling the supply of nutrients and removal of waste requires the coordinated activity of the heart and circulatory system.

Learning outcomes	Additional guidance
<i>Learners should be able to demonstrate and apply their knowledge and understanding of:</i>	
(a) the need for transport systems in multicellular animals	To include an appreciation of size, metabolic rate and surface area to volume ratio (SA:V). <i>M0.1, M0.3, M0.4, M1.1, M2.1, M4.1</i>  HSW1, HSW3, HSW5, HSW8
(b) the different types of circulatory systems	To include single, double, open and closed circulatory systems in insects, fish and mammals.
(c) the structure and functions of arteries, arterioles, capillaries, venules and veins	To include the distribution of different tissues within the vessel walls. <b>PAG2</b>

(d)	the formation of tissue fluid from plasma	To include reference to hydrostatic pressure, oncotic pressure and an explanation of the differences in the composition of blood, tissue fluid and lymph.  HSW8
(e)	(i) the external and internal structure of the mammalian heart  (ii) the dissection, examination and drawing of the external and internal structure of the mammalian heart	<b>PAG2</b> HSW4
(f)	the cardiac cycle	To include the role of the valves and the pressure changes occurring in the heart and associated vessels.  $\text{cardiac output} = \text{heart rate} \times \text{stroke volume}$  HSW2, HSW5, HSW8
(g)	how heart action is initiated and coordinated	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 of hormonal and nervous control is required at AS Level).  HSW2, HSW5, HSW8
(h)	the use and interpretation of electrocardiogram (ECG) traces	To include normal and abnormal heart activity (tachycardia, bradycardia, fibrillation and ectopic heartbeat only).  <i>M0.1, M1.1, M1.3, M2.4</i> HSW2, HSW5
(i)	the role of haemoglobin in transporting oxygen and carbon dioxide	To include the reversible binding of oxygen molecules, carbonic anhydrase, haemoglobinic acid, hydrogencarbonate ion and the chloride shift.  HSW8
(j)	the oxygen dissociation curve for fetal and adult human haemoglobin	To include the significance of the different affinities for oxygen <b>AND</b> the changes to the dissociation curve at different carbon dioxide concentrations (the Bohr effect).  <i>M3.1</i> HSW2, HSW8



### 3.1.3 Transport in plants

As plants become larger and more complex, transport systems become essential to supply nutrients to, and remove waste from, individual cells.

The supply of nutrients from the soil relies upon the flow of water through a vascular system, as does the movement of the products of photosynthesis.

Learning outcomes	Additional guidance
<i>Learners should be able to demonstrate and apply their knowledge and understanding of:</i>	
<b>(a)</b> the need for transport systems in multicellular plants	To include an appreciation of size, metabolic rate and surface area to volume ratio (SA:V).  <i>M0.1, M0.3, M0.4, M1.1, M2.1, M4.1</i> HSW1, HSW3, HSW5, HSW8
<b>(b)</b> <b>(i)</b> the structure and function of the vascular system in the roots, stems and leaves of herbaceous dicotyledonous plants	To include xylem vessels, sieve tube elements and companion cells.
<b>(ii)</b> the examination and drawing of stained sections of plant tissue to show the distribution of xylem and phloem	<b>PAG1</b> HSW4
<b>(iii)</b> the dissection of stems, both longitudinally and transversely, and their examination to demonstrate the position and structure of xylem vessels	<b>PAG2</b> HSW4
<b>(c)</b> <b>(i)</b> the process of transpiration and the environmental factors that affect transpiration rate	To include an appreciation that transpiration is a consequence of gaseous exchange.
<b>(ii)</b> practical investigations to estimate transpiration rates	To include the use of a potometer.  <i>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</i> <b>PAG5, PAG11</b> HSW2, HSW3, HSW4, HSW5, HSW6, HSW8
<b>(d)</b> the transport of water into the plant, through the plant and to the air surrounding the leaves	To include details of the pathways taken by water (apoplast and symplast pathways only). <b>AND</b> the mechanisms of movement, in terms of water potential, adhesion, cohesion and the transpiration stream.  HSW2, HSW8
<b>(e)</b> adaptations of plants to the availability of water in their environment	To include xerophytes (cacti and marram grass) and hydrophytes (water lilies).  HSW2

(f) the mechanism of translocation.

To include translocation as an energy-requiring process transporting assimilates, especially sucrose, in the phloem between sources (e.g. leaves) and sinks (e.g. roots, meristem)

**AND**

details of active loading at the source and removal at the sink.

HSW2, HSW8

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## Module 4: Biodiversity, evolution and disease

In this module the learners study the biodiversity of organisms; how they are classified and the ways in which biodiversity can be measured. It serves as an introduction to ecology, emphasising practical techniques and an appreciation of the need to maintain biodiversity. The learners also gain an understanding of the variety of organisms that are pathogenic and the way in which plants and animals have evolved defences to deal with disease. The

impact of the evolution of pathogens on the treatment of disease is also considered.

The relationships between organisms are studied, considering variation, evolution and phylogeny.

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

### 4.1 Communicable diseases, disease prevention and the immune system

#### 4.1.1 Communicable diseases, disease prevention and the immune system

Organisms are surrounded by pathogens and have evolved defences against them. Medical intervention

can be used to support these natural defences. The mammalian immune system is introduced.

Learning outcomes	Additional guidance
<i>Learners should be able to demonstrate and apply their knowledge and understanding of:</i>	
(a) the different types of pathogen that can cause communicable diseases in plants and animals	<p>To include:</p> <ul style="list-style-type: none"> <li>bacteria – tuberculosis (TB), ring rot (potatoes)</li> <li>viruses – HIV/AIDS (human), influenza (animals), Tobacco Mosaic Virus (plants)</li> <li>protocista – malaria, potato/tomato late blight</li> <li>fungi – black sigatoka (bananas), athlete's foot (humans).</li> </ul> <p>Learners are <b>not</b> required to know the binomial name of the pathogens that cause the diseases listed above.</p>

Learning outcomes	Additional guidance
(b) the means of transmission of animal and plant communicable pathogens	<p>To include an understanding of the different methods of transmission with reference to vectors, spores and living conditions – e.g. climate, social factors (no detail of the symptoms of specific diseases is required).</p> <p>Learners are not required to categorise pathogens between direct and indirect methods of transmission.</p> <p><i>M0.1, M0.2, M0.3, M1.1, M1.2, M1.3, M1.5, M1.7, M3.1, M3.2</i>  <i>HSW1, HSW2, HSW3, HSW5, HSW6, HSW7, HSW8, HSW11, HSW12</i></p>
(c) plant defences against pathogens	<p>To include production of chemicals  <b>AND</b>  plant responses that limit the spread of the pathogen (e.g. callose deposition).</p>
(d) the primary non-specific defences against pathogens in animals	<p>Non-specific defences to include skin, blood clotting (limited to platelets releasing substances that, via a cascade of events, result in the formation of fibrin which itself forms a network, trapping platelets and forming a clot), wound repair, inflammation, expulsive reflexes and mucous membranes.</p> <p>Learners are <b>not</b> required to recall names of clotting factors or all the steps of the clotting cascade.</p> <p>Learners are <b>not</b> required to recall details of skin structure.</p> <p><i>HSW2, HSW8</i></p>
(e) (i) the structure and mode of action of phagocytes (ii) examination and drawing of cells observed in blood smears	<p>To include neutrophils and antigen-presenting cells  <b>AND</b>  the roles of cytokines, opsonins, phagosomes and lysosomes.</p> <p><b>PAG1</b>  <i>HSW8</i></p>
(f) the structure, different roles and modes of action of B and T lymphocytes in the specific immune response	<p>To include the significance of cell signalling (reference to interleukins), clonal selection and clonal expansion, plasma cells, T helper cells and T killer cells.</p> <p><i>HSW8</i></p>
(g) the primary and secondary immune responses	<p>To include T memory cells and B memory cells.</p> <p><i>M1.3</i>  <i>HSW2</i></p>

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| <p>(h) the structure and general functions of antibodies</p>   | <p>To include the general protein structure of an antibody molecule.</p>   |
| <p>(i) an outline of the action of opsonins, agglutinins and anti-toxins</p>                                   |  |
| <p>(j) the differences between active and passive immunity, and between natural and artificial immunity</p>    | <p>To include examples of each type of immunity.</p>   |
| <p>(k) autoimmune diseases</p>   | <p>To include an appreciation of the term <i>autoimmune disease</i> and arthritis as a named example.</p>  |
| <p>(l) the principles of vaccination and the role of vaccination programmes in the prevention of epidemics</p> | <p>To include routine vaccinations<br/> <b>AND</b><br/> reasons for changes to vaccines and vaccination programmes (including global issues).</p> <p><i>M0.1, M0.2, M0.3, M1.1, M1.2, M1.3, M1.5, M1.7, M3.1, M3.2</i><br/> HSW1, HSW2, HSW3, HSW5, HSW6, HSW7, HSW8, HSW9, HSW11, HSW12</p> |
| <p>(m) possible sources of medicines</p>   | <p>To include examples of microorganisms and plants (and so the need to maintain biodiversity)<br/> <b>AND</b><br/> the potential for personalised medicines.</p> <p>HSW7, HSW9, HSW11, HSW12</p>  |
| <p>(n) the benefits and risks of using antibiotics to manage bacterial infection.</p>                          | <p>To include the wide use of antibiotics following the discovery of penicillin in the mid-20<sup>th</sup> century<br/> <b>AND</b><br/> the increase in bacterial resistance to antibiotics and its implications.</p> <p>HSW2, HSW5, HSW9, HSW12</p>   |

## 4.2 Biodiversity

### 4.2.1 Biodiversity

Biodiversity refers to the variety and complexity of life. It is an important indicator in the study of habitats.

Maintaining biodiversity is important for many reasons. Actions to maintain biodiversity must be taken at local, national and global levels.

Learning outcomes		Additional guidance
<i>Learners should be able to demonstrate and apply their knowledge and understanding of:</i>		
(a)	how biodiversity may be considered at different levels	<p>To include:</p> <ul style="list-style-type: none"><li>• habitat biodiversity (sand dunes, woodland, meadows, streams)</li><li>• species biodiversity (species richness and species evenness)</li><li>• genetic biodiversity (different breeds within a species).</li></ul>
(b)	(i) how sampling is used in measuring the biodiversity of a habitat and the importance of sampling	<p>To include how sampling can be carried out:</p> <ul style="list-style-type: none"><li>• random sampling</li><li>• non-random sampling (opportunistic, stratified and systematic)</li></ul> <p><b>AND</b> the importance of sampling the range of organisms in a habitat.</p> <p>Techniques to include: quadrats, sweep nets, pitfall traps and pooters.</p> <p><i>M0.2, M1.3, M1.5, M1.4, M1.6, M1.7, M1.9, M1.10, M3.2</i> <b>PAG3</b> HSW4, HSW5, HSW6</p>
	(ii) practical investigations collecting random and non-random samples in the field	
(c)	how to measure species richness and species evenness in a habitat	<p><i>M1.1, M1.5, M2.3, M2.4</i></p>

- (d) the use and interpretation of Simpson's Index of Diversity ( $D$ ) to calculate the biodiversity of a habitat

The formula will be provided where needed in assessments and does not need to be recalled.

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

**AND**

the interpretation of both high and low values of Simpson's Index of Diversity ( $D$ ).

*M1.1, M1.5, M2.3, M2.4*

HSW5

- (e) how genetic biodiversity may be assessed, including calculations

To include calculations of genetic diversity within isolated populations, for example the percentage of gene variants (alleles) in a genome.

proportion of polymorphic gene loci =

$$\frac{\text{number of polymorphic gene loci}}{\text{total number of loci}}$$

Suitable populations include zoos (captive breeding), rare breeds and pedigree animals.

*M1.1, M1.5, M2.3, M2.4*

HSW5

- (f) the factors affecting biodiversity

To include human population growth, agriculture (monoculture) and climate change.

*M1.3, M1.7, M3.1*

HSW5, HSW10, HSW12

- (g) the ecological, economic and aesthetic reasons for maintaining biodiversity

- Ecological: protecting keystone species (interdependence of organisms) and maintaining genetic resource.
- Economic: including reducing soil depletion (continuous monoculture).
- Aesthetic: including protecting landscapes.

HSW12

- (h) *in situ* and *ex situ* methods of maintaining biodiversity

- *In situ* conservation: marine conservation zones and wildlife reserves.
- *Ex situ* conservation: seed banks, botanic gardens and zoos.

HSW7, HSW9, HSW10, HSW12

- (i) international and local conservation agreements made to protect species and habitats.

Historic and/or current agreements, including the Convention on International Trade in Endangered Species (CITES), the Rio Convention on Biological Diversity (CBD) and the Countryside Stewardship Scheme (CSS).

HSW11, HSW12

#### 4.2.2 Classification and evolution

Evolution has generated a very wide variety of organisms. The fact that all organisms share a common ancestry allows them to be classified. Classification is an attempt to impose a hierarchy on the complex and dynamic variety of life on Earth.

Classification systems have changed and will continue to change as our knowledge of the biology of organisms develops.

Learning outcomes	Additional guidance
<i>Learners should be able to demonstrate and apply their knowledge and understanding of:</i>	
(a) the biological classification of species	To include the taxonomic hierarchy of kingdom, phylum, class, order, family, genus and species <b>AND</b> domain.  HSW1, HSW5, HSW6, HSW7
(b) the binomial system of naming species and the advantage of such a system	
(c) (i) the features used to classify organisms into the five kingdoms: Prokaryotae, Protoctista, Fungi, Plantae, Animalia	To include the use of similarities in observable features in original classification.
(ii) the evidence that has led to new classification systems, such as the three domains of life, which clarifies relationships	To include the more recent use of similarities in biological molecules and other genetic evidence <b>AND</b> details of the three domains and a comparison of the kingdom and domain classification systems.  HSW1, HSW5, HSW6, HSW7, HSW11, HSW12
(d) the relationship between classification and phylogeny	Learners are <b>not</b> required to know cladistics.  HSW5, HSW7
(e) the evidence for the theory of evolution by natural selection	To include the contribution of Darwin and Wallace in formulating the theory of evolution by natural selection <b>AND</b> fossil, DNA (only genomic DNA at AS Level) and molecular evidence.  HSW1, HSW2, HSW5, HSW6, HSW7



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| <p>(f) the different types of variation</p>  | <p>To include intraspecific and interspecific variation<br/> <b>AND</b><br/> the differences between continuous and discontinuous variation, using examples of a range of characteristics found in plants, animals and microorganisms<br/> <b>AND</b><br/> both genetic and environmental causes of variation.</p> <p><i>M1.2, M1.3, M1.6, M1.7, M1.10</i><br/> HSW4</p> |
| <p>(g) the different types of adaptations of organisms to their environment</p>                              | <p>Anatomical, physiological and behavioural adaptations<br/> <b>AND</b><br/> why organisms from different taxonomic groups may show similar anatomical features</p> <p>HSW5</p>   |
| <p>(h) the mechanism by which natural selection can affect the characteristics of a population over time</p> | <p>To include an appreciation that genetic variation, selection pressure and reproductive success (or failure) results in an increased proportion of the population possessing the advantageous characteristic(s).</p> <p><i>M0.3</i><br/> HSW8</p>  |
| <p>(i) how evolution in some species has implications for human populations.</p>                             | <p>To include the evolution of pesticide resistance in insects and drug resistance in microorganisms.<br/> HSW8, HSW9, HSW12</p>   |

## 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](http://www.ocr.org.uk)

# 3 Assessment of OCR AS Level in Biology A

## 3a. Forms of assessment

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

### Breadth in biology (Component 01)

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This component assesses content from across all teaching modules, 1–4.

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

**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). This section of the paper is worth 50 marks.

### Depth in biology (Component 02)

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This component assesses content from across all teaching modules, 1–4. 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 AS Level in Biology A. These are detailed in the table below.

Learners are expected to demonstrate their ability to:

	Assessment Objective
<b>AO1</b>	Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures.
<b>AO2</b>	Apply knowledge and understanding of scientific ideas, processes, techniques and procedures: <ul style="list-style-type: none"><li>• in a theoretical context</li><li>• in a practical context</li><li>• when handling qualitative data</li><li>• when handling quantitative data.</li></ul>
<b>AO3</b>	Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to: <ul style="list-style-type: none"><li>• make judgements and reach conclusions</li><li>• develop and refine practical design and procedures.</li></ul>

### AO weightings in AS Level in Biology A

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

Component	% of AS Level in Biology A (H020)		
	AO1	AO2	AO3
Breadth in biology (H020/01)	22–24	19–20	7–9
Depth in biology (H020/02)	13–16	21–24	13–14
<b>Total</b>	<b>35–40</b>	<b>40–44</b>	<b>20–23</b>

### 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 Biology A 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 to **all** learners.

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

All examined components must be taken in the same examination series at the end of the course.

### 3g. Retaking the qualification

Learners can retake the qualification as many times as they wish.

They retake all components of the qualification.

### 3h. Assessment of extended response

The assessment materials for this qualification provide learners with the opportunity to demonstrate their ability to construct and develop a sustained 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 A 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 A 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 A must be entered using the entry code H020.

Entry option		Components		
Entry code	Title	Code	Title	Assessment type
H020	Biology A	01	Breadth in biology	External assessment
		02	Depth in biology	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*.

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### 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](http://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 A'.

## 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 non exam assessment 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

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There is a small degree of overlap between the content of this specification and those for AS Chemistry, Physics, Science, Geography and Geology courses. The

links between the specifications may allow for some co-teaching, particularly in the areas of biochemistry, environmental science and microbiology.

### 5b. Avoidance of bias

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The AS level qualification and subject criteria have been reviewed in order to identify any feature which could disadvantage learners 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:

- **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
<b>Recall</b>	Magnification Rates $R_f$ $Q_{10}$ SA : V Genetic biodiversity Cardiac output $RQ$	All of GCSE (9–1) Maths recall including (but not limited to): <ul style="list-style-type: none"> <li>• circumference and area of circle</li> <li>• surface area and volume of cuboid</li> <li>• mean</li> <li>• percentage (to include %change, %yield and %error)</li> </ul>
<b>Provided</b>	Simpson’s index of diversity	Surface area and volume of cylinder and sphere chi squared $t$ -test paired $t$ -test unpaired Spearman’s rank 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

$$\text{circumference} = 2\pi r$$

- Area of circle

$$\text{area of circle} = \pi r^2$$

- Surface area of cuboid

$$\text{surface area of cuboid} = 2(bh + bl + hl)$$

- Volume of cuboid

$$\text{volume of cuboid} = hbl$$

- Mean

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

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

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

$$\% \text{ yield} = \frac{\text{actual amount}}{\text{theoretical amount}} \times 100$$

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

## Biological formulae to recall

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

- Magnification

$$\text{magnification} = \frac{\text{size of image}}{\text{size of real object}}$$

- $R_f$

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

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

$$\text{rate} = \frac{\text{change in quantity}}{\text{time taken}}$$

- Surface Area to Volume ratio

$$\text{ratio} = \frac{\text{surface area}}{\text{volume}}$$

- Genetic biodiversity

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

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

$$\text{cardiac output} = \text{heart rate} \times \text{stroke volume}$$

- Respiratory quotient

$$RQ = \frac{\text{CO}_2 \text{ produced}}{\text{O}_2 \text{ consumed}}$$

- Microorganism population growth

$$N = N_0 \times 2^n$$

- Temperature coefficient ( $Q_{10}$ )

$$Q_{10} = \frac{R_2}{R_1}$$

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

- Surface area of a cylinder

$$\text{surface area of cylinder} = 2\pi r(r + l)$$

- Volume of a cylinder

$$\text{volume of cylinder} = \pi r^2 l$$

- Surface area of a sphere

$$\text{surface area of sphere} = 4\pi r^2$$

- Volume of a sphere

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

- Chi squared

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

- Spearman's Rank Correlation Coefficient

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

- Standard Deviation

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

- Student's *t*-test – Unpaired

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

- Student's *t*-test – Paired

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

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)
<b>M0 – Arithmetic and numerical computation</b>			
M0.1	Recognise and make use of appropriate units in calculations	<p>Learners may be tested on their ability to:</p> <ul style="list-style-type: none"> <li>convert between units e.g. <math>\text{mm}^3</math> to <math>\text{cm}^3</math> as part of volumetric calculations</li> <li>work out the unit for a rate e.g. breathing rate</li> </ul>	2.1.1(e), 2.1.2(s), 2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.1(a), 3.1.1(e), 3.1.2(a), 3.1.2(h), 3.1.3(a), 3.1.3(c), 4.1.1(b), 4.1.1(l)
M0.2	Recognise and use expressions in decimal and standard form	<p>Learners may be tested on their ability to:</p> <ul style="list-style-type: none"> <li>use an appropriate number of decimal places in calculations, e.g. for a mean</li> <li>carry out calculations using numbers in standard and ordinary form, e.g. use of magnification</li> <li>understand standard form when applied to areas such as size of organelles</li> <li>convert between numbers in standard and ordinary form</li> <li>understand that significant figures need retaining when making conversions between standard and ordinary form, e.g. <math>0.0050 \text{ mol dm}^{-3}</math> is equivalent to <math>5.0 \times 10^{-3} \text{ mol dm}^{-3}</math>.</li> </ul>	2.1.1(e), 2.1.1(f), 2.1.1(g), 2.1.2(s), 2.1.4(d), 2.1.4(f), 2.1.5(b), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.1(e), 3.1.3(c), 4.1.1(b), 4.1.1(l), 4.2.1(b)
M0.3	Use ratios, fractions and percentages	<p>Learners may be tested on their ability to:</p> <ul style="list-style-type: none"> <li>calculate percentage yields</li> <li>calculate surface area to volume ratio</li> <li>use scales for measuring</li> <li>represent phenotypic ratios (monohybrid and dihybrid crosses).</li> </ul>	2.1.1(e), 2.1.1(f), 2.1.4(d), 2.1.4(f), 2.1.5(d), 2.1.5(e), 3.1.1(a), 3.1.2(a), 3.1.3(a), 4.1.1(b), 4.1.1(l), 4.2.2(h)

	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: <ul style="list-style-type: none"> <li>estimate results to sense check that the calculated values are appropriate.</li> </ul>	3.1.1(a), 3.1.1(e), 3.1.2(a), 3.1.3(a)
<b>M1 – Handling data</b>			
M1.1	Use an appropriate number of significant figures	Learners may be tested on their ability to: <ul style="list-style-type: none"> <li>report calculations to an appropriate number of significant figures given raw data quoted to varying numbers of significant figures</li> <li>understand that calculated results can only be reported to the limits of the least accurate measurement.</li> </ul>	2.1.1(e), 2.1.2(s), 2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.1(a), 3.1.2(a), 3.1.2(h), 3.1.3(a), 3.1.3(c), 4.1.1(b), 4.1.1(l), 4.2.1(c), 4.2.1(d), 4.2.1(e)
M1.2	Find arithmetic means	Learners may be tested on their ability to: <ul style="list-style-type: none"> <li>find the mean of a range of data, e.g. the mean number of stomata in the leaves of a plant.</li> </ul>	2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.3(c), 4.1.1(b), 4.1.1(l), 4.2.2(f)
M1.3	Construct and interpret frequency tables and diagrams, bar charts and histograms	Learners may be tested on their ability to: <ul style="list-style-type: none"> <li>represent a range of data in a table with clear headings, units and consistent decimal places</li> <li>interpret data from a variety of tables, e.g. data relating to organ function</li> <li>plot a range of data in an appropriate format, e.g. enzyme activity over time represented on a graph</li> <li>interpret data for a variety of graphs, e.g. explain electrocardiogram traces.</li> </ul>	2.1.2(s), 2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.1(e), 3.1.2(h), 3.1.3(c), 4.1.1(b), 4.1.1(g), 4.1.1(l), 4.2.1(b), 4.2.1(f), 4.2.2(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: <ul style="list-style-type: none"> <li>• use the terms probability and chance appropriately</li> <li>• understand the probability associated with genetic inheritance.</li> </ul>	4.2.1(b)
M1.5	Understand the principles of sampling as applied to scientific data	Learners may be tested on their ability to: <ul style="list-style-type: none"> <li>• analyse random data collected by an appropriate means, e.g. use Simpson's index of diversity to calculate the biodiversity of a habitat.</li> </ul>	4.1.1(b), 4.1.1(l), 4.2.1(b), 4.2.1(c), 4.2.1(d), 4.2.1(e)
M1.6	Understand the terms mean, median and mode	Learners may be tested on their ability to: <ul style="list-style-type: none"> <li>• calculate or compare the mean, median and mode of a set of data, e.g. height/mass/size of a group of organisms.</li> </ul>	2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.3(c), 4.2.1(b), 4.2.2(f)
M1.7	Use a scatter diagram to identify a correlation between two variables	Learners may be tested on their ability to: <ul style="list-style-type: none"> <li>• interpret a scattergram, e.g. the effect of lifestyle factors on health.</li> </ul>	4.1.1(b), 4.1.1(l), 4.2.1(b), 4.2.1(f), 4.2.2(f)
M1.8	Make order of magnitude calculations	Learners may be tested on their ability to: <ul style="list-style-type: none"> <li>• use and manipulate the magnification formula  <math display="block">\text{magnification} = \frac{\text{size of image}}{\text{size of real object}}</math> </li> </ul>	2.1.1(e)



	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: <ul style="list-style-type: none"> <li>the chi squared test to test (<math>\chi^2</math>) the significance of the difference between observed and expected results</li> <li>the Student's <i>t</i>-test</li> <li>the Spearman's rank correlation coefficient.</li> </ul>	4.2.1(b)
M1.10	Understand measures of dispersion, including standard deviation and range	Learners may be tested on their ability to: <ul style="list-style-type: none"> <li>calculate the standard deviation</li> <li>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.</li> </ul>	2.1.5(e), 4.2.1(b), 4.2.2(f)
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: <ul style="list-style-type: none"> <li>calculate percentage error where there are uncertainties in measurement.</li> </ul>	2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.3(c)
<b>M2 – Algebra</b>			
M2.1	Understand and use the symbols: =, <, «, », >, $\alpha$ , ~	No exemplification required.	2.1.5(d), 2.1.5(e), 3.1.1(a), 3.1.2(a), 3.1.3(a)
M2.2	Change the subject of an equation	Learners may be tested on their ability to: <ul style="list-style-type: none"> <li>use and manipulate equations, e.g. magnification.</li> </ul>	2.1.1(e), 2.1.2(s)

	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)
M2.3	Substitute numerical values into algebraic equations using appropriate units for physical quantities	Learners may be tested on their ability to: <ul style="list-style-type: none"> <li>use a given equation e.g. Simpson's-index of diversity</li> </ul> $D = 1 - \left( \sum \left( \frac{n}{N} \right)^2 \right)$	2.1.1(e), 2.1.2(s), 4.2.1(c), 4.2.1(d), 4.2.1(e)
M2.4	Solve algebraic equations	Learners may be tested on their ability to: <ul style="list-style-type: none"> <li>solve equations in a biological context, e.g.</li> </ul> cardiac output = stroke volume × heart rate	2.1.1(e), 2.1.2(s), 3.1.2(h), 4.2.1(c), 4.2.1(d), 4.2.1(e)
<b>M3 – Graphs</b>			
M3.1	Translate information between graphical, numerical and algebraic forms	Learners may be tested on their ability to: <ul style="list-style-type: none"> <li>understand that data may be presented in a number of formats and be able to use these data, e.g. dissociation curves.</li> </ul>	2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.2(j), 3.1.3(c), 4.1.1(b), 4.1.1(l), 4.2.1(f)
M3.2	Plot two variables from experimental or other data	Learners may be tested on their ability to: <ul style="list-style-type: none"> <li>select an appropriate format for presenting data, bar charts, histograms, graphs and scattergrams.</li> </ul>	2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 2.1.5(e), 3.1.3(c), 4.1.1(b), 4.1.1(l), 4.2.1(b)
M3.3	Understand that $y = mx + c$ represents a linear relationship	Learners may be tested on their ability to: <ul style="list-style-type: none"> <li>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.</li> </ul>	2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 3.1.3(c)
M3.5	Calculate rate of change from a graph showing a linear relationship	Learners may be tested on their ability to: <ul style="list-style-type: none"> <li>calculate a rate from a graph, e.g. rate of transpiration.</li> </ul>	2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 3.1.3(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)
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: <ul style="list-style-type: none"> <li>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.</li> </ul>	2.1.4(d), 2.1.4(f), 2.1.5(c), 2.1.5(d), 3.1.3(c)
<b>M4 – Geometry and trigonometry</b>			
M4.1	Calculate the circumferences, surface areas and volumes of regular shapes	Learners may be tested on their ability to: <ul style="list-style-type: none"> <li>calculate the circumference and area of a circle</li> <li>calculate the surface area and volume of rectangular prisms, of cylindrical prisms and of spheres</li> <li>e.g. calculate the surface area or volume of a cell.</li> </ul>	2.1.5(d), 2.1.5(e), 3.1.1(a), 3.1.2(a), 3.1.3(a), 3.1.3(c)

### 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 not 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*<sup>1</sup> 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®.

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<sup>1</sup> These, and other CLEAPSS® publications, are on the CLEAPSS® Science Publications website [www.cleapss.org.uk](http://www.cleapss.org.uk). Note that CLEAPSS® publications are only available to members. For more information about CLEAPSS® go to [www.cleapss.org.uk](http://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
May 2018	2.2	2c	Content of modules 1–4	Inclusion of additional guidance.
April 2020	2.3	1d	How do I find out more information?	Insertion of Online Support Centre link
		4e	Post-results services	Enquiries about results changed to Review of results
July 2020	2.4	4.2	Biodiversity	Correction to the formula for Simpson's Index of Diversity
				Update to specification covers to meet digital accessibility standards
August 2023	3	2c.	Content of modules 1 to 6	Changes to wording of learning outcomes to improve accessibility and clarity.  Changes to wording of additional guidance to improve accessibility and clarity.  No changes have been made to any assessment requirements.
		Multiple		Update of formulae formatting to improve accessibility.
		ii and 1d.	Introducing... A Level Biology A (from September 2015)	Update of the Science Subject Advisors contact email address and information for the newsletter signup.
		3	How do I find out more information?  Assessment of OCR AS Level in Biology A	Insertion of new section 3c. Total qualification time.

Date	Version	Section	Title of section	Change
February 2024	3.1	3d and 3e	Qualification availability and Language	Inclusion of disclaimer regarding availability and language
	4a		Pre-assessment	Update to include resilience guidance
	Checklist			Inclusion of Teach Cambridge
February 2025	3.2	4.1.1 (a)	Additional Guidance	Removal of 'tomato' as an example of ring rot



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# YOUR CHECKLIST

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*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 A
  - ☐ Sign up to [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](#)
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## Download high-quality, exciting and innovative AS and A Level Biology resources from [ocr.org.uk/alevelbiology](https://ocr.org.uk/alevelbiology)

Resources and support for our AS Level Biology qualification, developed through collaboration between our Biology Subject Advisor, teachers and other subject experts, are available from our website. You can also contact our Biology Subject Advisor who can give you specialist advice, guidance and support.

### Contact the team at:

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