Qualification Accredited

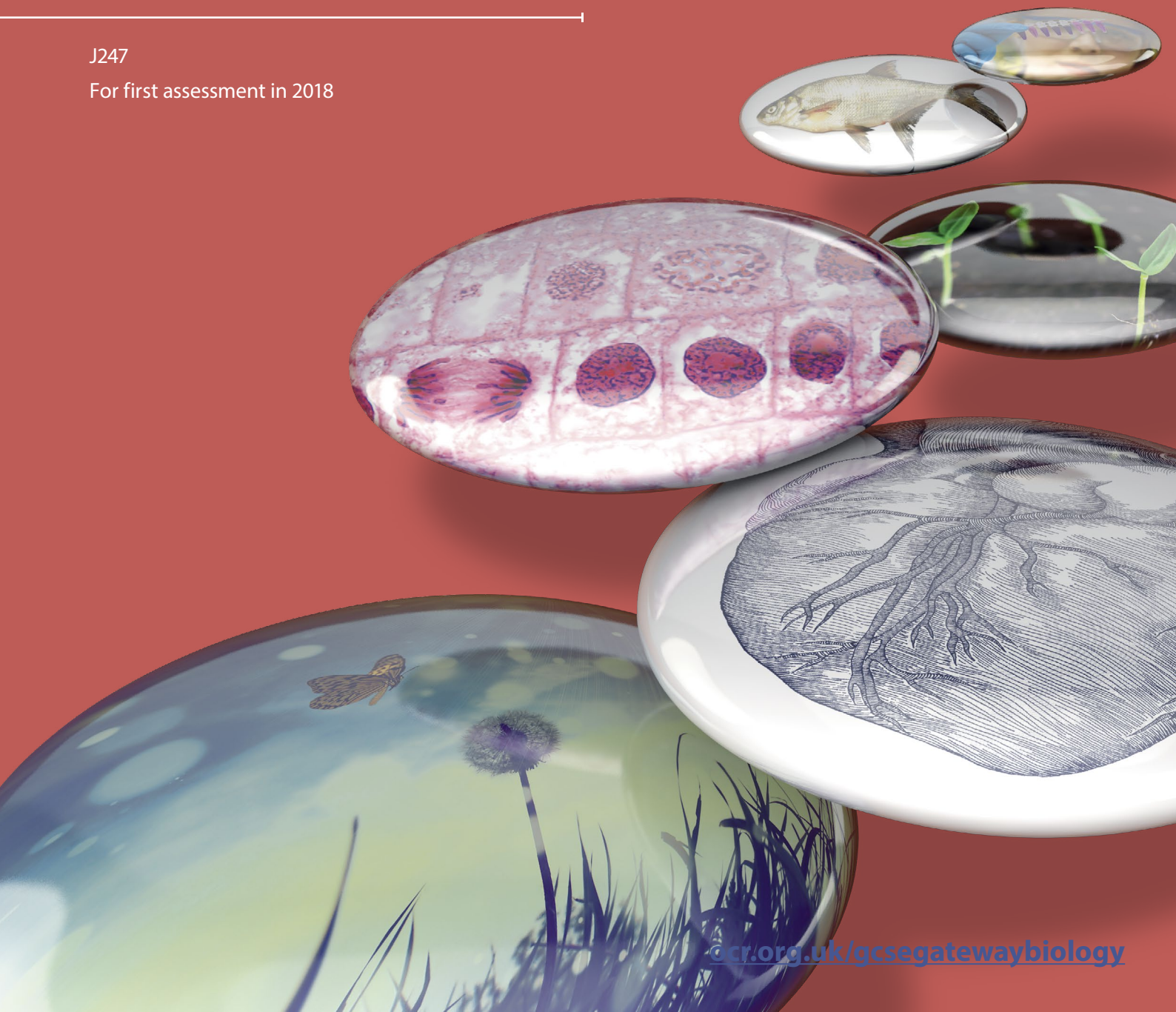
OCR
Oxford Cambridge and RSA

GCSE (9-1)
Specification

GATEWAY SCIENCE BIOLOGY A

J247

For first assessment in 2018



ocr.org.uk/gcsegatewaybiology

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OCR is an exempt charity.

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

Contents

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Introducing a new specification brings challenges for implementation and teaching, but it also opens up new opportunities. Our aim is to help you at every stage. We are working hard with teachers and other experts to bring you a package of practical support, resources and training.

Subject Specialists

OCR Subject Specialists provide information and support to centres including specification and non-exam assessment advice, updates on resource developments and a range of training opportunities.

Our Subject Specialists work with subject communities through a range of networks to ensure the sharing of ideas and expertise supporting teachers and students alike. They work with developers to help produce our specifications and the resources needed to support these qualifications during their development.

You can contact our Science Subject Specialists for specialist advice, guidance and support:

01223 553998
ScienceGCSE@ocr.org.uk
@OCR_Science

Teaching and learning resources

Our resources are designed to provide you with a range of teaching activities and suggestions that enable you to select the best activity, approach or context to support your teaching style and your particular students. The resources are a body of knowledge that will grow throughout the lifetime of the specification, they include:

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

We also work with a number of leading publishers who publish textbooks and resources for our specifications. For more information on our publishing partners and their resources visit: ocr.org.uk/qualifications/gcse-and-a-level-reform/publishing-partners

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Our improved Professional Development Programme fulfils a range of needs through course selection, preparation for teaching, delivery and assessment. 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: cpdhub.ocr.org.uk

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We run training events throughout the academic year that are designed to help prepare you for first teaching and support every stage of your delivery of the new qualifications.

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

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Enabling you to build, mark and assess tests from OCR exam questions and produce a complete mock GCSE or A Level exam. Find out more at **ocr.org.uk/examcreator**

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These guides cover topics that could be relevant to a range of qualifications, for example communication, legislation and research. Download the guides at **ocr.org.uk/skillsguides**

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Our free online results analysis service helps you review the performance of individual students or your whole cohort. For more details, please refer to **ocr.org.uk/activeresults**

1 Why choose an OCR GCSE (9–1) in Biology A (Gateway Science)?

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 OCR GCSE (9–1) in Biology A (Gateway Science) has been developed in consultation with teachers, employers and Higher Education (HE) to provide learners with a qualification that's relevant to them and meets their needs.

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

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

Our Specifications

We believe in developing specifications that help you bring the subject to life and inspire your learners 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 Specialists to support you through the transition and throughout the lifetime of the specifications.

- CPD/Training for teachers including face-to-face events 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 learners or whole schools.

- ExamCreator – our new online past papers service that enables you to build your own test papers from past OCR exam questions.

All GCSE (9–1) qualifications offered by OCR are accredited by Ofqual, the Regulator for qualifications offered in England. The accreditation number for OCR's GCSE (9–1) in Biology A (Gateway Science) is QN:601/8589/2.

1b. Why choose an OCR GCSE (9–1) in Biology A (Gateway Science)?

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

Biology A (Gateway Science) – 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.

Biology B (Twenty First Century Science) – Learners study biology using a narrative-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 GCSE 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 other stakeholders with the aim of including up-to-date relevant content within a framework that is interesting to teach and easy to administer within all centres.

Our new GCSE (9–1) in Biology A (Gateway Science) specification builds on our existing popular course. We've based the redevelopment of our GCSE sciences on an understanding of what works well in centres large and small. We've undertaken a significant amount of consultation through our science forums (which include representatives from: learned societies, HE, teaching and industry) and through focus groups with teachers.

The content is clear and logically laid out for both existing centres and those new to OCR, with assessment models that are straightforward to administer. We have worked closely with teachers to provide high quality support materials to guide you through the new qualifications.

Aims and learning outcomes

GCSE study in the sciences provides the foundation for understanding the material world. Scientific understanding is changing our lives and is vital to world's future prosperity, and all learners should be taught essential aspects of the knowledge, methods, process and uses of science. They should be helped to appreciate how the complex and diverse phenomena of the natural world can be described in terms of a small number of key ideas relating to the sciences which are both inter-linked, and are of universal application.

These key ideas include:

- the use of conceptual models and theories to make sense of the observed diversity of natural phenomena
- the assumption that every effect has one or more cause
- that change is driven by differences between different objects and systems when they interact
- that many such interactions occur over a distance and over time without direct contact
- that science progresses through a cycle of hypothesis, practical experimentation, observation, theory development and review
- that quantitative analysis is a central element both of many theories and of scientific methods of inquiry.

OCR's GCSE (9–1) in Biology A (Gateway Science) will encourage learners to:

- develop scientific knowledge and conceptual understanding of biology

- develop understanding of the nature, processes and methods of science, through different types of scientific enquiries that help them to answer scientific questions about the world around them
- develop and learn to apply observational, practical, modelling, enquiry and problem-solving skills, both in the laboratory, in the field and in other learning environments
- develop their ability to evaluate claims based on science through critical analysis of the methodology, evidence and conclusions, both qualitatively and quantitatively.

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

Our GCSE (9–1) in Biology A (Gateway Science) specification is designed with a context-led approach and provides a flexible way of teaching. The specification:

- is laid out clearly in a series of teaching topics with guidance included where required to provide further advice on delivery
- is co-teachable with the GCSE (9–1) in Combined Science A (Gateway Science)
- embeds practical requirements within the teaching topics
- identifies opportunities for carrying out practical activities that enhance learners' understanding of biology theory and practical skills
- highlights opportunities for the introduction of key mathematical requirements (see Appendix 5e and the To include column for each topic) into your teaching
- identifies, within the working scientifically column, how the skills, knowledge and understanding of working scientifically (WS) can be incorporated within teaching.

1d. How do I find out more information?

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

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

If you are not already a registered OCR centre then you can find out more information on the benefits of becoming one at: www.ocr.org.uk

If you are not yet an approved centre and would like to become one go to: www.ocr.org.uk

Want to find out more?

You can contact the Science Subject Specialists:

E-mail:
ScienceGCSE@ocr.org.uk

Telephone:
01223 553998

Join our Science Community:
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2 The specification overview

2a. OCR's GCSE (9–1) in Biology A (Gateway Science) (J247)

Learners are entered for either Foundation Tier (Paper 1 and Paper 2) or Higher Tier (Paper 3 and Paper 4).

Content Overview	Assessment Overview	
Foundation Tier, grades 5 to 1		
Content is split into six teaching topics B1-B6 and a practical activity skills topic B7: • Topic B1: Cell level systems • Topic B2: Scaling up • Topic B3: Organism level systems • Topic B4: Community level systems • Topic B5: Genes, inheritance and selection • Topic B6: Global challenges • Topic B7: Practical skills Paper 1 assesses content from Topics B1–B3 and B7. Paper 2 assesses content from Topics B4–B6 and B7, with assumed knowledge of Topics B1–B3	Paper 1 J247/01 90 marks 1 hour 45 minutes Written paper	**50% of total GCSE**
	Paper 2 J247/02 90 marks 1 hour 45 minutes Written paper	**50% of total GCSE**
Higher Tier, grades 9 to 4		
Content is split into six teaching topics B1-B6 and a practical activity skills topic B7: • Topic B1: Cell level systems • Topic B2: Scaling up • Topic B3: Organism level systems • Topic B4: Community level systems • Topic B5: Genes, inheritance and selection • Topic B6: Global challenges • Topic B7: Practical skills Paper 3 assesses content from Topics B1–B3 and B7 Paper 4 assesses content from Topics B4–B6 and B7, with assumed knowledge of Topics B1–B3.	Paper 3 J247/03 90 marks 1 hour 45 minutes Written paper	**50% of total GCSE**
	Paper 4 J247/04 90 marks 1 hour 45 minutes Written paper	**50% of total GCSE**

J247/02 and J247/04 include synoptic assessment.

2b. Content of GCSE (9–1) in Biology A (Gateway Science) (J247)

The GCSE (9–1) in Biology A (Gateway Science) specification content is specified in section 2c It is divided into six teaching topics B1-B6 and a practical activity skills topic B7.

Learning at GCSE (9–1) in Biology A (Gateway Science) is described in the tables that follow:

Overview of the content layout

Topic B1: Topic title

B1.1 sub-topic

Summary
A short overview of the sub-topic that will be assessed in the examinations.

Underlying knowledge and understanding
Underlying knowledge and understanding learners should be familiar with linked to the sub-topic.

Common misconceptions
Common misconceptions students often have associated with this topic.

Tiering
A brief summary of the tiering of the sub-topic.

Reference	Mathematical learning outcomes	Mathematical skills (See appendix 5e)
OCRs mathematics reference code	This column defines the areas of mathematics that will need to be taught specifically within the context of this sub-topic. Questions in the examination will assess these learning outcomes within the context of the topic.	Mathematical skill code as indicated in Appendix 5e

Topic content			**Opportunities to cover:** Items that are contained within these columns are intended as a starting point for lesson planning.		**Practical suggestions** (See topic B7)
Learning outcomes		**To include**	**Maths** (See appendix 5e)	**Working scientifically** (See appendix 5d)	
Specification reference number ☑	Column specifies the subject content that will be assessed in the examinations. This symbol indicates content that is found only in the biology separate science qualification.	This column is included to provide further/ specific advice on delivery of the learning outcome.	Mathematical skills will be assessed throughout the examination. This column highlights the mathematical skills that could be taught alongside the topic content.	Working scientifically will be assessed throughout the examination. This column highlights the working scientifically skills that could be taught alongside the topic content.	The compulsory Practical Activity Groups or PAGs are indicated in the table in Topic B7. Activities in this column can be used to supplement the PAGs using topic appropriate experiments.

Biology key ideas

Biology is the science of living organisms (including animals, plants, fungi and microorganisms) and their interactions with each other and the environment. The study of biology involves collecting and interpreting information about the natural world to identify patterns and relate possible cause and effect. Biological information is used to help humans improve their own lives and strive to create a sustainable world for future generations.

Learners should be helped to understand how, through the ideas of biology, the complex and diverse phenomena of the natural world can be described in terms of a small number of key ideas which are of universal application, and which can be illustrated in the separate topics set out below. These ideas include:

- life processes depend on molecules whose structure is related to their function
- the fundamental units of living organisms are cells, which may be part of highly adapted structures including tissues, organs and organ systems, enabling living processes to be performed effectively
- living organisms may form populations of single species, communities of many species and ecosystems, interacting with each other, with the environment and with humans in many different ways
- living organisms are interdependent and show adaptations to their environment
- life on Earth is dependent on photosynthesis in which green plants and algae trap light from the Sun to fix carbon dioxide and combine it with hydrogen from water to make organic compounds and oxygen
- organic compounds are used as fuels in cellular respiration to allow the other chemical reactions necessary for life
- the chemicals in ecosystems are continually cycling through the natural world
- the characteristics of a living organism are influenced by its genome and its interaction with the environment
- evolution occurs by a process of natural selection and accounts both for biodiversity and how organisms are all related to varying degrees.

Summary of content for GCSE (9–1) in Biology A (Gateway Science)

Topic B1: Cell level systems	Topic B2: Scaling up	Topic B3: Organism level systems
B1.1 Cell structures B1.2 What happens in cells (and what do cells need)? B1.3 Respiration B1.4 Photosynthesis	B2.1 Supplying the cell B2.2 The challenges of size	B3.1 Coordination and control – the nervous system B3.2 Coordination and control – the endocrine system B3.3 Maintaining internal environments
Topic B4: Community level systems	**Topic B5: Genes, inheritance and selection**	**Topic B6: Global challenges**
B4.1 Ecosystems	B5.1 Inheritance B5.2 Natural selection and evolution	B6.1 Monitoring and maintaining the environment B6.2 Feeding the human race B6.3 Monitoring and maintaining health

Topic 7 is a practical-based topic which provided learners with the necessary skills to undertake the 15% practical content in the examinations.

2c. Content of topics B1 to B6

Topic B1: Cell level systems

B1.1 Cell structures

Summary

Cells are the fundamental units of living organisms. Cells contain many sub-cellular structures that are essential for the functioning of the cell as a whole. Microscopy is used to examine cells and sub-cellular structures.

Underlying knowledge and understanding

Learners should be familiar with cells as the fundamental unit of living organisms, and with the use of light microscopes to view cells. They should also be familiar with some sub-cellular structures, and the similarities and differences between plant and animal cells.

Common misconceptions

Learners commonly have difficulty understanding the concept of a cell as a 3D structure, so this should be addressed during the teaching of this topic.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers. All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
BM1.1i	demonstrate an understanding of number, size and scale and the quantitative relationship between units	M2a and M2h
BM1.1ii	use estimations and explain when they should be used	M1d
BM1.1iii	**calculate with numbers written in standard form**	**M1b**

Topic content		Opportunities to cover:		Practical suggestions
Learning outcomes	**To include**	**Maths**	**Working scientifically**	
B1.1a describe how light microscopes and staining can be used to view cells	lenses, stage, lamp, use of slides and cover slips, and the use of stains to view colourless specimens or to highlight different structures/ tissues and calculation of magnification	**M1b**, M1d, M2a, M2h	WS1.2c, WS1.4c, WS1.4d, WS1.4e, WS2a, WS2b, WS2c, WS2d	Investigation of a range of cells using pictures, light micrographs and diagrams. Measure the size and magnification of the cells. (PAG B1, PAG B7) Preparation of cheek cell slides. (PAG B7) Preparation of onion epidermis cells slides. (PAG B7) Use of light microscopes to view plant and animal cells. (PAG B7)
B1.1b explain how the main sub-cellular structures of eukaryotic cells (plants and animals) and prokaryotic cells are related to their functions	nucleus, genetic material, chromosomes, plasmids, mitochondria (contain enzymes for cellular respiration), chloroplasts (contain chlorophyll) and cell membranes (contain receptor molecules, provides a selective barrier to molecules)		WS1.4a, WS2a, WS2b, WS2c, WS2d	Production of 3D model plant and animal cells to illustrate their differences. Investigation of cytoplasmic streaming in Elodea spp. (PAG B6, PAG B7)
B1.1c explain how electron microscopy has increased our understanding of sub-cellular structures	increased resolution in a transmission electron microscope	**M1b**	WS1.1a, WS1.4c, WS1.4d	Comparison of a range of cells using pictures from light and electron micrographs. Comparison of the visible structures visible on light and electron micrographs.

B1.2 What happens in cells (and what do cells need)?

Summary

Life processes depend on biological molecules whose structure is related to their function. Inside every cell is genetic material and this is used as a code to make proteins. Enzymes are important proteins in biology.

Underlying knowledge and understanding

Learners should have a simple understanding of the double helix model of DNA. Learners should be familiar with the idea of enzymes as biological catalysts.

Common misconceptions

Learners commonly hold the misconception that DNA is made of protein or sugar. Learners also think that all enzymes have an optimum temperature of 37°C (human body temperature). The range of optimum temperatures of enzymes should be introduced through the teaching of this topic and further addressed when considering homeostatic mechanisms for controlling temperature.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers. All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
BM1.2i	carry out rate calculations for chemical reactions	M1a and M1c
BM1.2ii	understand and use simple compound measures such as the rate of a reaction	M1a and M1c

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
B1.2a	describe DNA as a polymer			WS1.4a	Production of 3D models of DNA to illustrate its structure.
B1.2b	describe DNA as being made up of two strands forming a double helix				
B1.2c	describe that DNA is made from four different nucleotides; each nucleotide consisting of a common sugar and phosphate group with one of four different bases attached to the sugar	the pairs of complementary bases (A-T and G-C)		WS1.4a, WS2a, WS2b, WS2c, WS2d	Production of 3D models of DNA to illustrate its structure. Investigation of DNA extraction from a living organism (e.g. kiwi, leek, onion, wheat germ). (PAG B2)
B1.2d ☑	**recall a simple description of protein synthesis**	**the unzipping of the DNA molecule around the gene, copying to mRNA in nucleus (transcription), (translation) of the nucleotide sequence, in the cytoplasm**			Comparison of transcription and translation to a non-lending library. Use of kinaesthetic activities to demonstrate transcription and translation.
B1.2e ☑	**explain simply how the structure of DNA affects the proteins made in protein synthesis**	**triplet code and its use to determine amino acid order in a protein**			

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
B1.2f	describe experiments that can be used to investigate enzymatic reactions		M1a, M1c, M2g	WS1.1h, WS1.2b, WS1.2c, WS1.2e, WS1.3a, WS1.3b, WS1.3c, WS1.3d, WS1.3e, WS1.3f, WS1.3g, WS2a, WS2b, WS2c, WS2d	Investigations of enzyme activity, including numerical analysis of data and graphical representation of results. (PAG B2, PAG B4, PAG B6)
B1.2g	explain the mechanism of enzyme action	the role of enzymes in metabolism, the role of the active site, enzyme specificity (lock and key hypothesis) and factors affecting the rate of enzyme controlled reactions (pH, temperature, substrate and enzyme concentration)	M1a, M1c, M3d, M4b	WS2a, WS2b, WS2c, WS2d	Investigation into the effect of amylase on a baby rice paste. (PAG B2, PAG B4, PAG B6) Investigation of enzyme controlled reactions. (PAG B2, PAG B4, PAG B6) Work out rate equations using simple algebraic equations. (PAG B4)

B1.3 Respiration

Summary
Metabolic processes such as respiration are controlled by enzymes. Organic compounds are used as fuels in cellular respiration to allow the other chemical reactions necessary for life.

Underlying knowledge and understanding
Learners should also have some underpinning knowledge of respiration. This should include that respiration involves the breakdown of organic molecules to enable all the other chemical processes necessary for life. Learners should be able to recall the word equation for respiration.

Common misconceptions
Learners commonly hold the misconception that ventilation is respiration. They can also get confused between the terms breakup and breakdown.

Tiering
Statements shown in **bold** type will only be tested in the Higher Tier papers. All other statements will be assessed in both Foundation and Higher Tier papers.

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
B1.3a	describe cellular respiration as a universal chemical process, continuously occurring that supplies ATP in all living cells			WS1.2a	
B1.3b	describe cellular respiration as an exothermic reaction			WS1.2b	Demonstration of an exothermic reaction (e.g. heat pack).
B1.3c	compare the processes of aerobic respiration and anaerobic respiration	in plants/fungi and animals the different conditions, substrates, products and relative yields of ATP		WS2a, WS2b, WS2c, WS2d	Research into whether plants respire. (PAG B2, PAG B4, PAG B5, PAG B6) Investigation of fermentation in fungi. (PAG B2, PAG B4, PAG B5, PAG B6) Investigation of respiration in yeast using alginate beads to immobilise the fungus. (PAG B2, PAG B4, PAG B5, PAG B6)

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
B1.3d	explain the importance of sugars in the synthesis and breakdown of carbohydrates	use of the terms monomer and polymer			Demonstration of the synthesis and breakdown of biological molecules (e.g. using Lego bricks).
B1.3e	explain the importance of amino acids in the synthesis and breakdown of proteins	use of the terms monomer and polymer			
B1.3f	explain the importance of fatty acids and glycerol in the synthesis and breakdown of lipids				

B1.4 Photosynthesis

Summary
Life processes depend on photosynthesis. Green plants and algae trap light from the Sun to fix carbon dioxide with hydrogen from water making organic compounds.

Underlying knowledge and understanding
Learners should also have some underpinning knowledge of photosynthesis. They should have an understanding that plants make carbohydrates in their leaves by photosynthesis, and be able to recall the word equation for photosynthesis.

Common misconceptions
Learners often think that plants do not respire.

Tiering
Statements shown in **bold** type will only be tested in the Higher Tier papers. All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
BM1.4i	understand and use simple compound measures such as the rate of a reaction	M1a and M1c
BM1.4ii	translate information between graphical and numerical form	M4a
BM1.4iii	plot and draw appropriate graphs, selecting appropriate scales and axes	M4a and M4c
BM1.4iv	extract and interpret information from graphs, charts and tables	M2c and M4a
BM1.4v	**understand and use inverse proportion – the inverse square law and light intensity in the context of factors affecting photosynthesis**	**M1c**

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
B1.4a	describe photosynthetic organisms as the main producers of food and therefore biomass for life on Earth				Use of concept cartoons to start discussions about photosynthesis.
B1.4b	describe the process of photosynthesis	reactants and products, two-stage process, location of the reaction (in the chloroplasts)		WS2a, WS2b, WS2c, WS2d	Investigation of photosynthesis e.g. the Priestley experiment using *Cabomba* to collect oxygen or the Ingenhousz experiment to show mass gain. (PAG B4, PAG B5, PAG B6)
B1.4c	describe photosynthesis as an endothermic reaction			WS1.3b, WS1.3c, WS1.3e	Demonstrate of an endothermic reaction (e.g. icepack).
B1.4d	describe experiments to investigate photosynthesis			WS2a, WS2b, WS2c, WS2d	Experiments to show the consequences of light exclusion on photosynthesising plants (e.g. testing geraniums for starch). (PAG B4, PAG B5, PAG B6)
B1.4e	explain the effect of temperature, light intensity and carbon dioxide concentration on the rate of photosynthesis		M1a, M1c, M4a, M4b, M4c, M2g	WS2a, WS2b, WS2c, WS2d	Investigation of photosynthesis in algae using alginate beads to immobilize the algae. (PAG B4, PAG B5, PAG B6)
B1.4f	**explain the interaction of these factors in limiting the rate of photosynthesis**		M1d, M2c, M4a, **M1c**	WS1.2b, WS1.2c, WS1.2e WS1.3a, WS1.3b, WS1.3c, WS1.3d, WS1.3f, WS1.3g, WS1.4e, WS2c, WS2d	

Topic B2: Scaling up

B2.1 Supplying the cell

Summary

Cells transport many substances across their membranes by diffusion, osmosis and active transport. Stem cells are found in both plants and animals. These stem cells can divide, differentiate and become specialised to form tissues, organs and organ systems.

Underlying knowledge and understanding

Learners should be familiar with the role of diffusion in the movement of materials in and between cells.

Common misconceptions

Learners commonly show some confusion regarding surface area: volume ratio, particularly how larger animals have a smaller surface area: volume ratio. They also show some confusion as to stem cells: where they are found and their roles. Care should be taken to give clear definitions when covering this content.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers. All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
BM2.1i	use percentiles and calculate percentage gain and loss of mass	M1c

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
B2.1a	explain how substances are transported into and out of cells through diffusion, osmosis and active transport	examples of substances moved, direction of movement, concentration gradients and use of the term water potential (no mathematical use of water potential required)	M1c, M1d	WS2a, WS2b, WS2c, WS2d	Observation of osmosis in plant cells using a light microscope. Investigation of 'creaming yeast' to show osmosis. (PAG B6, PAG B8) Investigation into changes in mass of vegetable chips when placed in sucrose/salt concentrations of varying concentrations. (PAG B6, PAG B8)
B2.1b	describe the process of mitosis in growth, including the cell cycle	the stages of the cell cycle as DNA replication, movement of chromosomes, followed by the growth of the cell		WS2a, WS2b, WS2c, WS2d	Modelling of mitosis using everyday objects e.g. shoes, socks etc. Observation of mitosis in stained root tip cells. (PAG B1, PAG B6, PAG B7)
B2.1c	explain the importance of cell differentiation	the production of specialised cells allowing organisms to become more efficient and examples of specialised cells		WS2a, WS2b, WS2c, WS2d	Examination of a range of specialised cells using a light microscope. (PAG 1)
B2.1d	recall that stem cells are present in embryonic and adult animals and meristems in plants				Demonstration of cloning using cauliflower. (PAG B6, PAG B7)
B2.1e	describe the functions of stem cells	division to produce a range of different cell types for development, growth and repair		WS1.1e, WS1.1f, WS1.1h	
B2.1f	describe the difference between embryonic and adult stem cells in animals				Research into the different types of stem cells.

B2.2 The challenges of size

Summary

When organisms become multicellular, the need arises for highly adapted structures including gaseous exchange surfaces and transport systems, enabling living processes to be performed effectively.

Underlying knowledge and understanding

Learners should be familiar with the role of diffusion in the movement of materials in and between cells. They should also be familiar with the human gaseous exchange system.

Common misconceptions

Learners have a view that the slow flow of blood in capillaries is due to the narrow diameter, when in fact it is a function of the total cross-sectional area of the capillaries (1000 times greater than the aorta). When explaining the importance of the slow flow of blood in allowing time for exchange by diffusion, this misunderstanding should be considered.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers. All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
BM2.2i	calculate surface area : volume ratios	M1c
BM2.2ii	use simple compound measures such as rate	M1a and M1c
BM2.2iii	carry out rate calculations	M1a and M1c
BM2.2iv	plot, draw and interpret appropriate graphs	M4a, M4b, M4c and M4d

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
B2.2a	explain the need for exchange surfaces and a transport system in multicellular organisms in terms of surface area : volume ratio	surface area, volume and diffusion distances	M1c	WS1.4d, WS1.4e, WS1.4f, WS2a, WS2b, WS2c, WS2d	Investigating surface area : volume ratio using hydrochloric acid and gelatine cubes stained with phenolphthalein or other suitable pH indicator. (PAG B8)
B2.2b	describe some of the substances transported into and out of a range of organisms in terms of the requirements of those organisms	oxygen, carbon dioxide, water, dissolved food molecules, mineral ions and urea			
B2.2c	describe the human circulatory system	the relationship with the gaseous exchange system, the need for a double circulatory system in mammals and the arrangement of vessels			Modelling of the human circulatory system.
B2.2d	explain how the structure of the heart and the blood vessels are adapted to their functions	the structure of the mammalian heart with reference to valves, chambers, cardiac muscle and the structure of blood vessels with reference to thickness of walls, diameter of lumen, presence of valves		WS2a, WS2b, WS2c, WS2d	Investigating heart structure by dissection. Investigation of a blood smear using a light microscope. (PAG B1) Modelling of blood using sweets to represent the components.
B2.2e	explain how red blood cells and plasma are adapted to their transport functions in the blood			WS2a, WS2b, WS2c, WS2d	Examine the gross structure of blood vessels using a light microscope. (PAG B1) Investigating of the elasticity of different blood vessels using hanging masses.

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
B2.2f	explain how water and mineral ions are taken up by plants, relating the structure of the root hair cells to their function			WS2a, WS2b, WS2c, WS2d	Examination of root hair cells using a light microscope. (PAG B1) Demonstration of the effectiveness of transpiration by trying to suck water from a bottle using a 10m straw. (PAG B8) Investigation of the position of the xylem/phloem in root, stem and leaf tissues using a light microscope. (PAG B1) Interpretation of experimental evidence of the movement of dissolved food materials in a plant. (PAG B1, PAG B8)
B2.2g	describe the processes of transpiration and translocation	the structure and function of the stomata		WS2a, WS2b, WS2c, WS2d	Measurement of plant stomatal density by taking an impression of the leaf using clear nail varnish or spray-on plaster. (PAG B1, PAG B6, PAG B8)
B2.2h	explain how the structure of the xylem and phloem are adapted to their functions in the plant				
B2.2i	explain the effect of a variety of environmental factors on the rate of water uptake by a plant	light intensity, air movement, and temperature	M1a, M1c, M1d	WS2a, WS2b, WS2c, WS2d	Interpreting experimental evidence of investigations into environmental factors that affect water uptake. (PAG B6, PAG B8)
B2.2j	describe how a simple potometer can be used to investigate factors that affect the rate of water uptake		M1a, M1c, M1d, M2g, M3d, M4a, M4b, M4c, M4d	WS1.2b, WS1.2c, WS1.2e WS1.3a, WS1.3b, WS1.3c, WS1.3d, WS1.3e, WS1.3f, WS1.3g, WS2a, WS2b, WS2c, WS2d	Investigation of transpiration rates from a plant cutting. (PAG B6, PAG B8) Work out the rate of transpiration in volume of water/time. (PAG B6, PAG B8)

Topic B3: Organism level systems

B3.1 Coordination and control – the nervous system

Summary
The human nervous system is an important part of how the body communicates with itself and also receives information from its surroundings.

Underlying knowledge and understanding
Learners should have a concept of the hierarchical organism of multicellular organisms from cells to tissues to organs to systems to organisms.

Common misconceptions
Learners commonly think that their eyes see objects 'directly', like a camera, but the reality is that the image formed by the brain is based on the eyes and brains interpretation of the light that comes into the eye i.e. different people will perceive the same object or image differently. Young learners also have the misconception that some sort of 'force' comes out of the eye, enabling it to see.

Tiering
Statements shown in **bold** type will only be tested in the Higher Tier papers. All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
BM3.1i	extract and interpret data from graphs, charts and tables	M2c

Topic content		Opportunities to cover:		Practical suggestions
Learning outcomes	**To include**	**Maths**	**Working scientifically**	
B3.1a describe the structure of the nervous system	Central Nervous System, sensory and motor neurones and sensory receptors			Production of 3D models of neurones to illustrate their structure.
B3.1b explain how the components of the nervous system can produce a coordinated response	it goes to all parts of the body, has many links, has different sensory receptors and is able to coordinate responses			Demonstration (by video) of someone trying to do everyday tasks whilst being given mild electric shocks (e.g. BBC Brainiac).
B3.1c explain how the structure of a reflex arc is related to its function			M1d, WS2a, WS2b, WS2c, WS2d	Demonstration of reaction time by getting a learner to catch a falling £5 note. Research into reflexes. (PAG B6) Investigating of reaction times by ruler drop. (PAG B6)

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
B3.1d ☑	explain how the main structures of the eye are related to their functions	cornea, iris, pupil, lens, retina, optic nerve, ciliary body, suspensory ligaments			Demonstration of the inversion of an image through a beaker full of water. Demonstration of the features of the human eye. Investigation of eye structure by dissection. (PAG B1)
B3.1e ☑	describe common defects of the eye and explain how some of these problems may be overcome	colour blindness, short-sightedness and long-sightedness		WS2a, WS2b, WS2c, WS2d	Measurement of focal length in a variety of situations. (PAG B6) Research into eye defects, their diagnosis and treatment.
B3.1f ☑	describe the structure and function of the brain	cerebrum, cerebellum, medulla, hypothalamus, pituitary			
B3.1g ☑	**explain some of the difficulties of investigating brain function**	**the difficulty in obtaining and interpreting case studies and the consideration of ethical issues**			Discussion of problems associated with brain research including the difficulty in getting research subjects.
B3.1h ☑	**explain some of the limitations in treating damage and disease in the brain and other parts of the nervous system**	**limited ability to repair nervous tissue, irreversible damage to the surrounding tissues, difficulties with accessing parts of the nervous system**		WS1.1e, WS1.1f, WS1.1h	Research into a study of brain injury.

B3.2 Coordination and control – the endocrine system

Summary

Hormones are chemical messengers. In animals, hormones are transported around the body in the blood and affect target tissues and organs. Hormones have a variety of roles in the human body, including controlling reproduction. Plant hormones are chemicals that regulate plant growth and development. They can be used in agriculture to control the rate of growth.

Underlying knowledge and understanding

Learner should be aware of a number of hormones including adrenaline and the male and female sex hormones.

Common misconceptions

With regards to the menstrual cycle, research has shown that learners have problems relating the time of conception to the condition of the lining of the uterus.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers. All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
BM3.2i	extract and interpret data from graphs, charts and tables	M2c
BM3.2ii	translate information between numerical and graphical forms	M4a

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
B3.2a	describe the principles of hormonal coordination and control by the human endocrine system	use of chemical messengers, transport in blood, endocrine glands and receptors			
B3.2b	**explain the roles of thyroxine and adrenaline in the body**	thyroxine as an example of a negative feedback system			

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
B3.2c	describe the role of hormones in human reproduction including the control of the menstrual cycle	oestrogen, progesterone, FSH and testosterone		WS1.3b, WS1.3e	
B3.2d	**explain the interactions of FSH, LH, oestrogen and progesterone in the control of the menstrual cycle**		M2c, M4a, M2g		Analysis of relative hormones levels from raw data and graphically.
B3.2e	explain the use of hormones in contraception and evaluate hormonal and non-hormonal methods of contraception	relative effectiveness of the different forms of contraception	M2c, M4a	WS1.1d, WS1.1e, WS1.1f	Discussion into the various methods of contraception and their effective/ethical use.
B3.2f	**explain the use of hormones in modern reproductive technologies to treat infertility**			WS1.1d, WS1.1e, WS1.1f, WS1.1h	Research into *Xenopus laevis* pregnancy testing to detect hCG by the stimulation of oogenesis. Research into hormonal treatments for infertility.
B3.2g ☑	explain how plant hormones are important in the control and coordination of plant growth and development, with reference to the role of auxins in phototropisms and gravitropisms	unequal distribution of auxin		WS2a, WS2b, WS2c, WS2d	Investigation of the effects of phototropism using seedlings. (PAG B6)
B3.2h ☑	describe some of the variety of effects of plant hormones, relating to auxins, **gibberellins and ethene**	controlling growth, controlling germination, fruit ripening, flower opening and shedding of leaves		WS2a, WS2b, WS2c, WS2d	Investigation/research into the question 'does one bad banana spoil the fruit bowl?' (PAG B2, PAG B6)
B3.2i ☑	**describe some of the different ways in which people use plant hormones to control plant growth**	**selective herbicides, root cuttings, seedless fruit (parthenocarpic fruit development), altering dormancy**			

B3.3 Maintaining internal environments

Summary
Homeostasis is crucial to the regulation of internal environments and enables organisms to adapt to change, both internally and externally. Internal temperature, blood sugar levels and osmotic balance are regulated by a number of organs and systems working together.

Underlying knowledge and understanding
Learners will build on the knowledge and understanding gained in section 3.1 about coordination and control when considering the topics in this section.

Common misconceptions
Learners often confuse type 1 and type 2 diabetes, and the effective treatments for each. The effect of ADH on the permeability of the kidney tubules is often confused.

Tiering
Statements shown in **bold** type will only be tested in the Higher Tier papers. All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
BM3.3i	extract and interpret data from graphs, charts and tables	M2c

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
B3.3a	explain the importance of maintaining a constant internal environment in response to internal and external change	allowing metabolic reactions to proceed at appropriate rates		WS1.4a	Research into hypothermia.
B3.3b ☑	describe the function of the skin in the control of body temperature	detection of external temperature, sweating, shivering, change to blood flow		WS2a, WS2b, WS2c, WS2d	Demonstration of the cooling effect of sweating using alcohol based surgical wipes. (PAG B6) Investigation into heat loss by using microwaved plasticine shapes/model 'animals' by using a UV heat camera/thermometers. (PAG B6)
B3.3c	explain how insulin controls blood sugar levels in the body		M2g		

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
B3.3d	**explain how glucagon interacts with insulin to control blood sugar levels in the body**		M2c	WS2a, WS2b, WS2c, WS2d	Investigations into the glucose content of artificial urine to diagnose diabetes, using e.g. Clinistix. (PAG B6)
B3.3e	compare type 1 and type 2 diabetes and explain how they can be treated				
B3.3f ☑	explain the effect on cells of osmotic changes in body fluids	higher, lower or equal water potentials leading to lysis or shrinking (no mathematical use of water potentials required)		WS2a, WS2b, WS2c, WS2d	Demonstration of the different water potentials on different cells. (PAG B6, PAG B8)
B3.3g ☑	describe the function of the kidneys in maintaining the water balance of the body	varying the amount and concentration of urine and hence water excreted		WS1.3b, WS2a, WS2b, WS2c, WS2d	Investigation of the structure of the structure of a kidney by dissection and the application of H_2O_2 to visualise the nephrons. (PAG B6, PAG B8) Investigations into the glucose content of artificial urine to diagnose diabetes, using e.g. Clinistix. (PAG B6)
B3.3h	describe the gross structure of the kidney and the structure of the kidney tubule				
B3.3i ☑	**describe the effect of ADH on the permeability of the kidney tubules**	**amount of water reabsorbed and negative feedback**		WS2a, WS2b, WS2c, WS2d	Investigation of the different sections of a nephron and the composition of the filtrate from each area. (PAG B2, PAG B6, PAG B8)
B3.3j ☑	**explain the response of the body to different temperature and osmotic challenges**	**challenges to include high sweating and dehydration, excess water intake, high salt intake responses to include mechanism of kidney function, thirst**			Research into sports drinks and evaluation into which is best for athletes. (PAG B2, PAG B6, PAG B8)

Topic B4: Community level systems

B4.1 Ecosystems

Summary
Microorganisms play an important role in the continuous cycling of chemicals in ecosystems. Biotic and abiotic factors interact in an ecosystem and have an effect on communities. Living organisms form populations of single species, communities of many species and are part of ecosystems. Living organisms are interdependent and show adaptations to their environment. Feeding relationships reflect the stability of an ecosystem and indicate the flow of biomass through the ecosystem.

Underlying knowledge and understanding
Learners should be familiar with the idea of a food web and the interrelationships associated with them and that variation allows living things to survive in the same ecosystem. They should also recognise that organisms affect their environment and are affected by it.

Common misconceptions
Research has shown that it is easier for a learner to explain the consequences on a food web if the producers are removed for some reason than if the top predators are taken away. It is also better to start off explaining ideas relating to food webs using small simple webs with animals and plants that learners are likely to know e.g. rabbits and foxes. Learners find arrows showing the flow of biomass from one trophic level to another quite challenging and often mistake it for the direction of predation. This makes problems relating to the manipulation of a food web quite difficult for some.

Tiering
Statements shown in **bold** type will only be tested in the Higher Tier papers. All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
BM4.1i ☑	calculate rate changes in the decay of biological material	M1c
BM4.1ii	calculate the percentage of mass	M1c
BM4.1iii	Use fractions and percentages	M1c
BM4.1iv	plot and draw appropriate graphs selecting appropriate scales for the axes	M4a and M4c
BM4.1v	extract and interpret information from charts, graphs and tables	M2c and M4a

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
B4.1a	recall that many different materials cycle through the abiotic and biotic components of an ecosystem	examples of cycled materials e.g. nitrogen and carbon			
B4.1b	explain the role of microorganisms in the cycling of materials through an ecosystem	the role of microorganisms in decomposition			Research into the range of ecosystems and examples of micro-organisms that act as decomposers within them. (PAG B1, PAG B3, PAG B4, PAG B7)
B4.1c	explain the importance of the carbon cycle and the water cycle to living organisms	maintaining habitats, fresh water flow of nutrients			
B4.1d ☑	explain the effect of factors such as temperature, water content, and oxygen availability on rate of decomposition	the terms aerobic and anaerobic	M1c, M2c, M4a, M4c	WS1.1b, WS1.1h, WS1.2b, WS1.2c, WS1.2e, WS1.3a, WS1.3b, WS1.3c, WS1.3d, WS1.3e, WS1.3f, WS1.3g, WS2a, WS2b, WS2c, WS2d	Investigation of the most favourable conditions for composting. (PAG B1, PAG B3, PAG B4, PAG B7)
B4.1e	describe different levels of organisation in an ecosystem from individual organisms to the whole ecosystem				
B4.1f	explain how abiotic and biotic factors can affect communities	temperature, light intensity, moisture level, pH of soil, predators, food	M3a	WS1.3a, WS1.3b, WS1.3e WS1.3h, WS2a, WS2b, WS2c, WS2d	Identification of the biotic factors in an ecosystem using sampling techniques. (PAG B3)

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
B4.1g	describe the importance of interdependence and competition in a community	interdependence relating to predation, mutualism and parasitism		WS1.4a, WS2a, WS2b, WS2c, WS2d	Examination of the roots of a leguminous plant e.g. clover to observe the root nodules. (PAG B1) Investigation of the holly leaf miner or the horse-chestnut leaf miner (*Cameraria ohridella*) (PAG B1, PAG B3)
B4.1h ☑	describe the differences between the trophic levels of organisms within an ecosystem	use of the terms producer and consumer			Investigation of the trophic levels within a children's story (e.g. *The Gruffalo*)
B4.1i ☑	describe pyramids of biomass and explain, with examples, how biomass is lost between the different trophic levels	loss of biomass related to egestion, excretion, respiration	M1c, M4a	WS1.3c, WS1.3e	Discussion of the best food source for humans (e.g. 'wheat vs. meat') Production of ecological pyramids.
B4.1j ☑	calculate the efficiency of biomass transfers between trophic levels and explain how this affects the number of trophic levels in a food chain		M1c		Calculation of the biomass transfers using real data.

Topic B5: Genes, inheritance and selection

B5.1 Inheritance

Summary
Inheritance relies on the genetic information contained in the genome being passed from one generation to the next, whether sexually or asexually. The characteristics of a living organism are influenced by the genome and its interaction with the environment.

Underlying knowledge and understanding
Learners should be familiar with the idea of heredity as the process by which genetic information is passed from one generation to the next. They should have a simple model of chromosomes, genes and DNA.

Common misconceptions
Learners commonly struggle to appreciate the physical relationships between the nucleus, genetic material, the genome, chromosomes and genes. Accurate definitions of these terms will help learners' explanations in this topic. Learners often have well-developed (although not necessarily scientifically accurate) explanations for inheritance before undertaking GCSE study. Some examples include that intra-specific variation is as a result of defects in development or that acquired characteristics can be inherited. Care must also be taken with the concept of dominant and recessive alleles. Whether an allele is dominant or recessive does not affect the mechanism of inheritance of the allele, but is an observed pattern in the phenotype of organisms. Many learners assume that the dominant allele 'dominates' the recessive allele preventing its expression (which is not the case) or that the recessive allele is actually just an absence of the dominant allele (also not generally the case).

Tiering
Statements shown in **bold** type will only be tested in the Higher Tier papers. All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
BM5.1i	understand and use direct proportions and simple ratios in genetic crosses	M1c
BM5.1ii	understand and use the concept of probability in predicting the outcome of genetic crosses	M2e
BM5.1iii	extract and interpret information from charts, graphs and tables	M2c and M4a

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
B5.1a	explain the following terms: gamete, chromosome, gene, allele/variant, dominant, recessive, homozygous, heterozygous, genotype and phenotype				Use of alleles to work out the phenotype of progeny.
B5.1b	describe the genome as the entire genetic material of an organism				
B5.1c	describe that the genome, and its interaction with the environment, influence the development of the phenotype of an organism	use of examples of discontinuous and continuous variation e.g. eye colour, weight and height			
B5.1d	Recall that all variants arise from mutations, and that most have no effect on the phenotype, some influence phenotype and a very few determine phenotype				
B5.1e ☑	**describe how genetic variants may influence phenotype:** • **in coding DNA by altering the activity of a protein** • **in non-coding DNA by altering how genes are expressed**	• **in coding: DNA related to mutations affecting protein structure, including active sites of enzymes** • **in non-coding: DNA related to stopping transcription of mRNA (use of terms promoter, transcription factor not required)**			
B5.1f ☑	explain some of the advantages and disadvantages of asexual and sexual reproduction in a range of organisms	the number of live offspring per birth, how quickly the organisms can reproduce verses the need for the introduction of variation in a population caused by environmental pressures			
B5.1g	explain the terms haploid and diploid				

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
B5.1h	explain the role of meiotic cell division in halving the chromosome number to form gametes	that this maintains diploid cells when gametes combine and is a source of genetic variation			
B5.1i	explain single gene inheritance	the context of homozygous and heterozygous crosses involving dominant and recessive genes	M2c, M4a		Prediction of the probability of phenotype for genetic crosses. Investigation into probability by suitable example (e.g. coin toss or die roll).
B5.1j	predict the results of single gene crosses		M1c, M2c, M2e, M4a		
B5.1k	describe sex determination in humans using a genetic cross		M1c, M2c, M2e, M4a		
B5.1l	recall that most phenotypic features are the result of multiple genes rather than single gene inheritance				
B5.1m ☑	describe the development of our understanding of genetics	the work of Mendel		WS1.1a, WS1.1d, WS1.1f, WS1.1i	

B5.2 Natural selection and evolution

Summary

Variation in the genome and changes in the environment drive the process of natural selection, leading to changes in the characteristics of populations. Evolution accounts for both biodiversity and how organisms are all related to varying degrees. Key individuals have played important roles in the development of our understanding of genetics.

Underlying knowledge and understanding

Learners should appreciate that changes in the environment can leave some individuals, or even some entire species, unable to compete and reproduce leading to extinction.

Common misconceptions

Learners are used to hearing the term evolution in everyday life but it is often used for items that have been designed and gradually improved in order to fit a purpose. They therefore find it difficult to grasp the idea that evolution by natural selection relies on random mutations. Learners also tend to imply that individuals change by natural selection. Statements such as 'a moth will change by natural selection in order to become better camouflaged' include both of these common misconceptions.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers.
All other statements will be assessed in both Foundation and Higher Tier papers.

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
B5.2a	state that there is usually extensive genetic variation within a population of a species				
B5.2b	describe the impact of developments in biology on classification systems	natural and artificial classification systems and use of molecular phylogenetics based on DNA sequencing		WS1.1b	
B5.2c	explain how evolution occurs through the natural selection of variants that have given rise to phenotypes best suited to their environment	the concept of mutation			
B5.2d	describe evolution as a change in the inherited characteristics of a population over time, through a process of natural selection, which may result in the formation of new species				
B5.2e	describe the evidence for evolution	fossils and antibiotic resistance in bacteria		WS1.1c, WS1.1d, WS1.1g	

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
B5.2f ☑	describe the work of Darwin and Wallace in the development of the theory of evolution by natural selection and explain the impact of these ideas on modern biology	seedbanks being used as a store of biodiversity		WS1.1a, WS1.1d, WS1.1g, WS1.1h, WS1.3i	

Topic B6: Global challenges

This topic seeks to integrate learners' knowledge and understanding of biological systems and processes, with the aim of applying it to global challenges. Biological information is used to help people to improve their own lives and strive to create a sustainable world for future generations. This topic provides opportunities to draw together the concepts covered in earlier topics, allowing synoptic treatment of the subject.

B6.1 Monitoring and maintaining the environment

Summary

Living organisms interact with each other, the environment and with humans in many different ways. If the variety of life is to be maintained we must actively manage our interactions with the environment. We must monitor our environment, collecting and interpreting information about the natural world, to identify patterns and relate possible cause and effect.

Underlying knowledge and understanding

From their study in topic B4, learners should be familiar with ecosystems and the various ways organisms interact. They should understand how biotic and abiotic factors influence communities. Learners should be familiar with the gases of the atmosphere from Key Stage 3.

Common misconceptions

It is important that in the study of this topic learners are given opportunities to explore both positive and negative human interactions within ecosystems.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers. All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
BM6.1i	construct and interpret frequency tables and diagrams, bar charts and histograms	M2c
BM6.1ii	understand the principles of sampling as applied to scientific data	M2d

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
B6.1a	explain how to carry out a field investigation into the distribution and abundance of organisms in a habitat and how to determine their numbers in a given area	sampling techniques (random and transects, capture-recapture), use of quadrats, pooters, nets, keys and scaling up methods	M2c, M2d, M3a	WS1.2d, WS1.2b, WS1.2c, WS1.2e, WS1.3h, WS2a, WS2b, WS2c, WS2d	Investigation of ecological sampling methods. Using the symbols =, <, <<, >>, >, ∝, ~ in answers where appropriate. (PAG B1, PAG B3) Investigation of sampling using a suitable model (e.g. measuring the red sweets in a mixed selection).
B6.1b	describe both positive and negative human interactions within ecosystems and explain their impact on biodiversity	the conservation of individual species and selected habitats and threats from land use and hunting		WS2a, WS2b, WS2c, WS2d	Investigation into the effectiveness of germination in different strengths of acid rain. (PAG B3, PAG B6) Investigation into the effects of lichen distribution against pollution. (PAG B3)
B6.1c	explain some of the benefits and challenges of maintaining local and global biodiversity	the difficulty in gaining agreements for and the monitoring of conservation schemes along with the benefits of ecotourism			
B6.1d ☑	**evaluate the evidence for the impact of environmental changes on the distribution of organisms, with reference to water and atmospheric gases**				

B6.2 Feeding the human race

Summary

The human population is increasing rapidly and with this comes a need for more food. Biologists are seeking to tackle this increased demand, which will lead to an improvement in the lives of many people around the world. However, there are many things to consider in achieving this aim, not least the impact on ecosystems. There is much debate surrounding the use of gene technology as a potential solution to the problem of food security.

Underlying knowledge and understanding

Learners should be familiar with the content of a healthy human diet and the consequences of imbalances in a healthy daily diet. Their knowledge and understanding from topics 1, 4 and 5 will also be drawn together in this topic. This includes the organisation of DNA, what plants require enabling them to photosynthesise, interactions between species and the idea of variability within species and subsequent selection of characteristics.

Common misconceptions

Learners can often think that genetic engineering leads to the increased use of pesticides.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers. All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
BM6.2i	use percentiles and calculate percentage gain and loss of mass	M1c
BM6.2ii	calculate arithmetic means	M2b
BM6.2iii	use fractions and percentages	M1c
BM6.2iv	extract and interpret information from charts, graphs and tables	M2c and M4a

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
B6.2a ☑	describe some of the biological factors affecting levels of food security	increasing human population, changing diets in wealthier populations, new pests and pathogens, environmental change, sustainability and cost of agricultural inputs	M2b, M2f		
B6.2b ☑	describe and explain some possible agricultural solutions to the demands of the growing human population	increased use of hydroponics, biological control, gene technology, fertilisers and pesticides		WS1.1c	
B6.2c	explain the impact of the selective breeding of food plants and domesticated animals		M1c, M2c, M4a	WS1.1c	Research into the Rothamsted Research Broadbalk experiment.
B6.2d	describe genetic engineering as a process which involves modifying the genome of an organism to introduce desirable characteristics				
B6.2e	**describe the main steps in the process of genetic engineering**	**restriction enzymes, sticky ends, vectors e.g. plasmids, ligase, host bacteria and selection using antibiotic resistance markers**			Produce a storyboard of the processes for genetic engineering.
B6.2f ☑	explain some of the possible benefits and risks of using gene technology in modern agriculture	practical and ethical considerations		WS1.1c, WS1.1d, WS1.1e, WS1.1f, WS1.1g, WS1.1h, WS1.3i	Research into the advantages and disadvantages of selective breeding and genetic engineering.
B6.2g	describe and explain some possible biotechnological solutions to the demands of the growing human population	genetic modification	M1c, M2c, M4a	WS1.1c, WS1.1g	Research into the growth of GM crops or livestock.

B6.3 Monitoring and maintaining health

Summary

Diseases affect the health of populations of both humans and plants. Scientists are constantly on the lookout for ways of preventing and combating disease. The prevention of disease in plants is important so that we are able to grow healthy plants enabling us to feed ourselves and enhance our environment. The understanding of how disease is spread, how our bodies defend themselves against disease and how immunity is achieved is essential to enable us to combat potentially fatal diseases spreading throughout whole populations. Non-communicable diseases also have an impact on the health of the population. The prevention of these diseases is frequently discussed in the media, with advice being given to us on how to reduce our risk of contracting these diseases through our life-style choices and discussion of new technologies.

Underlying knowledge and understanding

Learners should be familiar with the effects of 'recreational' drugs (including substance misuse) on behaviour, health and life processes, the impact of exercise, asthma and smoking on the gas exchange system and the consequences of imbalances in the diet, including obesity, starvation and deficiency diseases.

Common misconceptions

Research has shown that learners tend to view all micro-organisms as being non-beneficial. They tend to consider health as just physical and do not consider mental health. Learners also confuse which diseases are inherited and which are caught. They see cancer as a genetic disease.

Tiering

Statements shown in **bold** type will only be tested in the Higher Tier papers. All other statements will be assessed in both Foundation and Higher Tier papers.

Reference	Mathematical learning outcomes	Mathematical skills
BM6.3i	translate information between graphical and numerical forms	M4a
BM6.3ii	construct and interpret frequency tables and diagrams, bar charts and histograms	M2c
BM6.3iii	understand the principles of sampling as applied to scientific data	M2d
BM6.3iv	use a scatter diagram to identify a correlation between two variables	M2g
BM6.3v ☑	calculate cross-sectional areas of bacterial cultures and clear agar jelly using πr^2	M5c

Topic content			Opportunities to cover:		Practical suggestions
Learning outcomes		To include	Maths	Working scientifically	
B6.3a	describe the relationship between health and disease				
B6.3b	describe different types of diseases	communicable and non-communicable diseases			
B6.3c	describe the interactions between different types of disease	HIV and tuberculosis; HPV and cervical cancer	M4a		
B6.3d	explain how communicable diseases (caused by viruses, bacteria, protists and fungi) are spread in animals and plants	scientific quantities, number of pathogens, number of infected cases, estimating number of cases	M2c, M2g	WS1.4b	
B6.3e	explain how the spread of communicable diseases may be reduced or prevented in animals and plants	detection of the antigen, DNA testing, visual identification of the disease	M2c	WS1.4b	
B6.3f	describe a minimum of one common human infection, one plant disease and sexually transmitted infections in humans including HIV/AIDS	plant diseases: virus tobacco mosaic virus TMV, fungal *Erysiphe graminis* barley powdery mildew, bacterial *Agrobacterium tumafaciens* crown gall disease			
B6.3g ☑	describe physical plant defence responses to disease	leaf cuticle, cell wall			
B6.3h ☑	describe chemical plant defence responses	antimicrobial substances			
B6.3i ☑	**describe different ways plant diseases can be detected and identified, in the lab and in the field**	**the laboratory detection of the DNA or antigen from the disease causing organism. The field diagnosis by observation and microscopy**			
B6.3j	explain how white blood cells and platelets are adapted to their defence functions in the blood				

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
B6.3k	describe the non-specific defence systems of the human body against pathogens				
B6.3l	explain the role of the immune system of the human body in defence against disease				
B6.3m ☑	**describe how monoclonal antibodies are produced**			WS1.1d	
B6.3n ☑	**describe some of the ways in which monoclonal antibodies can be used**	**their role in detecting antigens in pregnancy testing, detection of diseases (prostate cancer) and potentially treating disease (targeting cancer cells)**			
B6.3o	explain the use of vaccines and medicines in the prevention and treatment of disease	antibiotics, antivirals and antiseptics		WS1.1g, WS1.1h	Research into whether children should be routinely vaccinated?
B6.3p ☑	explain the aseptic techniques used in culturing organisms	use of alcohol, flaming, autoclaving of glassware and growth media, and measures used to stop contaminants falling onto/into the growth media (e.g. working around a Bunsen burner)	M3d, M5c	WS1.1h, WS1.2c, WS2a, WS2b, WS2c, WS2d	Investigation into growth bacterial cultures using aseptic techniques. (PAG B1, PAG B7)
B6.3q	describe the processes of discovery and development of potential new medicines	preclinical and clinical testing	M2d, M3d, M5c	WS1.1d, WS2a, WS2b, WS2c, WS2d	Investigation into growth bacterial cultures using aseptic techniques. (PAG B1, PAG B7)
B6.3r	recall that many non-communicable human diseases are caused by the interaction of a number of factors	cardiovascular diseases, many forms of cancer, some lung (bronchitis) and liver (cirrhosis) diseases and diseases influenced by nutrition, including type 2 diabetes			
B6.3s	evaluate some different treatments for cardiovascular disease	lifestyle, medical and surgical	M2g		

Learning outcomes		To include	Maths	Working scientifically	Practical suggestions
B6.3t	analyse the effect of lifestyle factors on the incidence of non-communicable diseases at local, national and global levels	lifestyle factors to include exercise, diet, alcohol and smoking	M2c, M2d, M4a		
B6.3u	describe cancer as the result of changes in cells that lead to uncontrolled growth and division				
B6.3v	discuss potential benefits and risks associated with the use of stem cells in medicine	tissue transplantation and rejection		WS1.1c, WS1.1d, WS1.1e, WS1.1f, WS1.1g, WS1.1h, WS1.1j	
B6.3w	explain some of the possible benefits and risks of using gene technology in medicine	practical and ethical considerations		WS1.1c, WS1.1d, WS1.1e, WS1.1j	
B6.3x	discuss the potential importance for medicine of our increasing understanding of the human genome	the ideas of predicting the likelihood of diseases occurring and their treatment by drugs which are targeted to genomes		WS1.1c, WS1.1d, WS1.1j	

2c. Topic B7: Practical skills

Compliance with the requirements for practical work

It is compulsory that learners complete at least *eight* practical activities. OCR has split the requirements from the Department for Education '*Biology, chemistry and physics GCSE subject content, July 2015*' – Appendix 4 into eight Practical Activity Groups or PAGs.

The Practical Activity Groups allow centres flexibility in their choice of activity. Upon completion of at least eight practical activities, each learner must have had the opportunity to use all of the apparatus and techniques described in the following tables of this topic.

The tables illustrate the apparatus and techniques required for each PAG and an example practical that may be used to contribute to the PAG. It should be noted that some apparatus and techniques can be used in more than one PAG. It is therefore important that teachers take care to ensure that learners do have the opportunity to use all of the required apparatus and techniques during the course with the activities chosen by the centre.

Within the specification there are a number of practicals that are described in the 'Practical suggestions' column. These can count towards each PAG. We are expecting that centres will provide learners with opportunities to carry out a wide range of practical activities during the course. These can be the ones described in the specification or can be practicals that are devised by the centre. Activities can range from whole investigations to simple starters and plenaries.

It should be noted that the practicals described in the specification need to be covered in preparation for the 15% of questions in the written examinations that will assess practical skills. Learners also need to be prepared to answer questions using their knowledge and understanding of practical apparatus, techniques and procedures in written papers.

Safety is an overriding requirement for all practical work. Centres are responsible for ensuring appropriate safety procedures are followed whenever their learners complete practical work.

Use and production of appropriate scientific diagrams to set up and record apparatus and procedures used in practical work is common to all science subjects and should be included wherever appropriate.

Revision of the requirements for practical work

OCR will review the practical activities detailed in Topic 7 of this specification following any revision by the Secretary of State of the apparatus or techniques published specified in respect of the GCSE Biology A (Gateway Science) qualification.

OCR will revise the practical activities if appropriate.

If any revision to the practical activities is made, OCR will produce an amended specification which will be published on the OCR website. OCR will then use the following methods to communicate the amendment to Centres: Notice to Centres sent to all Examinations Officers. e-alerts to Centres that have registered to teach the qualification and social media.

The following list includes opportunities for choice and use of appropriate laboratory apparatus for a variety of experimental problem-solving and/or enquiry based activities.

Practical Activity Group (PAG)	Apparatus and techniques that the practical must use or cover	Example of a suitable biology activity (a range of practicals are included in the specification and centres can devise their own activity) *
1 Microscopy	Use of appropriate apparatus, techniques and magnification, including microscopes, to make observations of biological specimens and produce labelled scientific drawings[7]	Investigate different magnification techniques to draw scientific diagrams from a number of biological specimens
	Use of appropriate apparatus to make and record a range of measurements accurately, including length, area, mass, time, temperature, volume of liquids and gases, and pH [1]	
2 Testing for biological molecules	Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater[2]	Testing foods for the presence of biological molecules in a range of foods
	Use of appropriate techniques and qualitative reagents to identify biological molecules and processes in more complex and problem-solving contexts including continuous sampling in an investigation.	
3 Sampling techniques	Application of appropriate sampling techniques to investigate the distribution and abundance of organisms in an ecosystem via direct use in the field (to include: biotic and abiotic factors)	Investigation the differences in habitats using ecological sampling techniques
	Use of appropriate apparatus to make and record a range of measurements accurately, including length, area, mass, time, temperature, volume of liquids and gases, and pH [1]	
4 Rates of enzyme-controlled reactions	Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater[2]	Investigate the factors that can affect the rate of enzyme activity
	Use of appropriate apparatus and techniques for the observation and measurement of biological changes and/or processes[3]	
	Measurement of rates of reaction by a variety of methods including production of gas, uptake of water and colour change of indicator[5]	
	Use of appropriate apparatus to make and record a range of measurements accurately, including length, area, mass, time, temperature, volume of liquids and gases, and pH [1]	

Practical Activity Group (PAG)	Apparatus and techniques that the practical must use or cover	Example of a suitable biology activity (a range of practicals are included in the specification and centres can devise their own activity) *
5 Photosynthesis	Use of appropriate apparatus and techniques for the observation and measurement of biological changes and/or processes[3]	Investigate the factors that can affect the rate of photosynthesis on *Cabomba*
	Safe and ethical use of living organisms (plants or animals) to measure physiological functions and responses to the environment[4]	
	Measurement of rates of reaction by a variety of methods including production of gas, uptake of water and colour change of indicator[5]	
	Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater[2]	
	Use of appropriate apparatus to make and record a range of measurements accurately, including length, area, mass, time, temperature, volume of liquids and gases, and pH [1]	
6 Physiology, responses respiration	Safe and ethical use of living organisms (plants or animals) to measure physiological functions and responses to the environment[4]	Investigate the effect of exercise on pulse rate/ ventilation rate and recovery
	Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater[2]	
7 Microbiological techniques	Use of appropriate apparatus and techniques for the observation and measurement of biological changes and/or processes[3]	Investigate the effectiveness of antimicrobial agents on the growth of a bacterial lawn
	Use of appropriate apparatus, techniques and magnification, including microscopes, to make observations of biological specimens and produce labelled scientific drawings[7]	
	Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater[2]	
	Use of appropriate apparatus to make and record a range of measurements accurately, including length, area, mass, time, temperature, volume of liquids and gases, and pH [1]	
8 Transport in and out of cells	Use of appropriate apparatus and techniques for the observation and measurement of biological changes and/or processes[3]	Investigate the effect of different water potentials on the length and mass of potato chips
	Use of appropriate apparatus to make and record a range of measurements accurately, including length, area, mass, time, temperature, volume of liquids and gases, and pH [1]	

*** Centres are free to substitute alternative practical activities that also cover the apparatus and techniques from Appendix 4. See 'Choice of activity' on page 50**

[1, 2, 3, 4, 5, 7] These apparatus and techniques may be covered in any of the groups indicated. Numbers correspond to those used in Appendix 4.

Choice of activity

Centres can include additional apparatus and techniques within an activity beyond those listed as the minimum in the above tables. Learners *must* complete a *minimum of eight* practicals covering all the apparatus and techniques listed.

The apparatus and techniques can be covered:
(i) by using OCR suggested activities (provided as resources)
(ii) through activities devised by the Centre.

Centres can receive guidance on the suitability of their own practical activities through our free coursework consultancy service (e-mail: ScienceGCSE@ocr.org.uk).

Where Centres devise their own practical activities to cover the apparatus and techniques listed above, the practical must cover all the requirements and be of a level of demand appropriate for GCSE 9–1. Each set of apparatus and techniques described in the middle column can be covered by more than one Centre devised practical activity e.g. "measurement of rates of reaction by a variety of methods including production of gas, uptake of water and colour change of indicator" could be split into two or more activities (rather than one).

Practical science statement

Centres must provide a written 'practical science statement' to OCR confirming that it has taken reasonable steps to secure that each learner:

a) has completed the practical activities set by OCR as detailed in Topic 7
b) has made a contemporaneous record of:
   (i) the work which the learner has undertaken during those practical activities, and
   (ii) the knowledge, skills and understanding which that learner has derived from those practical activities.

Centres must provide practical science opportunities for their learners. This does not go so far as to oblige centres to ensure that all of their learners take part in all of the practical science opportunities. There is always a risk that an individual learner may miss the arranged practical science work, for example because of illness. It could be costly for the centre to run additional practical science opportunities for the learner.

However, the opportunities to take part in the specified range of practical work must be given to all learners. Learners who do not take up the full range of opportunities may be disadvantaged as there will be questions on practical science in the GCSE Biology A (Gateway Science) assessment.

Centres must provide the practical science statement by 15 May in the year the learner certificates. Any failure by a centre to provide a practical science statement to OCR in a timely manner will be treated as malpractice and/or maladministration [under General Condition A8 (*Malpractice and maladministration*)].

Private candidates

Private candidates can be entered for examinations at an OCR-approved centre even if they are not enrolled as a learner there.

Private candidates may be home-schooled, receiving private tuition or self-taught. They must be based in the UK.

The GCSE Biology A (Gateway Science) qualification requires learners to complete eight practical activities. These practical activities are an essential part of the course and will allow learners to develop skills for further study or employment as well as imparting important knowledge that is part of the specification.

Private candidates need to make contact with a centre where they will be allowed to carry out the required practical activities. The centre may charge for this facility and OCR recommends that the arrangement is made early in the course.

There is no direct assessment of the practical skills part of the course. However, learners will need to have completed the activities to prepare fully for the written examinations as there will be questions that assess practical skills.

2d. Prior knowledge, learning and progression

- Learners in England who are beginning a GCSE (9–1) course are likely to have followed a Key Stage 3 programme of study.
- There are no prior qualifications required in order for learners to enter for a GCSE (9–1) in Biology A (Gateway Science).
- GCSEs (9–1) are qualifications that enable learners to progress to further qualifications either Vocational or General.

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

3 Assessment of GCSE (9–1) in Biology A (Gateway Science)

3a. Forms of assessment

The GCSE (9–1) in Biology A (Gateway Science) is a linear qualification with 100% external assessment.

OCR's GCSE (9–1) in Biology A (Gateway Science) consists of four examined papers that are externally assessed. Two are at Foundation Tier and two are at Higher Tier. Learners are entered for either the Foundation Tier or Higher Tier. Each paper carries an equal weighting of 50% for that tier of the GCSE (9–1) qualification. Each paper has a duration of 1 hour and 45 minutes.

Biology Paper 1 and Paper 3

These papers, one at Foundation Tier and one at Higher Tier, are each worth 90 marks, are split into two sections and assess content from Topics B1 to B3 and B7.

Section A contains multiple choice questions. This section of the paper is worth 15 marks.

Section B includes short answer question styles (practical, maths, structured questions) and an extended six-mark Level of Response question. This section of the paper is worth 75 marks.

Biology Paper 2 and Paper 4

These papers, one at Foundation Tier and one at Higher Tier, are each worth 90 marks, are split into two sections and assess content from Topics B4 to B6, with assumed knowledge of Topics B1 to B3 and B7.

Section A contains multiple choice questions. This section of the paper is worth 15 marks.

Section B includes short answer question styles (practical, maths, synoptic questions, structured questions) and an extended six-mark Level of Response question. This section of the paper is worth 75 marks, some of which will be synoptic.

3b. Assessment objectives (AO)

There are three Assessment Objectives in OCR GCSE (9–1) in Biology A (Gateway Science).

These are detailed in the table below:

Assessment Objectives		Weighting (%)	
		Higher	Foundation
AO1	**Demonstrate knowledge and understanding of:** • scientific ideas • scientific techniques and procedures.	40	40
AO2	**Apply knowledge and understanding of:** • scientific ideas • scientific enquiry, techniques and procedures.	40	40
AO3	**Analyse information and ideas to:** • interpret and evaluate • make judgements and draw conclusions • develop and improve experimental procedures.	20	20

AO weightings in OCR GCSE (9–1) in Biology A (Gateway Science)

The relationship between the Assessment Objectives and the components are shown in the following table:

	% of overall GCSE (9–1) in Biology A (Gateway Science) (J247)			
Component (Foundation Tier)	**AO1**	**AO2**	**AO3**	**Total**
Paper 1 (Foundation Tier) J247/01	20	20	10	50
Paper 2 (Foundation Tier) J247/02	20	20	10	50
Total	40	40	20	100
Component (Higher Tier)	**AO1**	**AO2**	**AO3**	**Total**
Paper 3 (Higher Tier) J247/03	20	20	10	50
Paper 4 (Higher Tier) J247/04	20	20	10	50
Total	40	40	20	100

3c. Tiers

This scheme of assessment consists of two tiers: Foundation Tier and Higher Tier. Foundation Tier assesses grades 5 to 1 and Higher Tier assesses grades 9 to 4. An allowed grade 3 may be awarded on the Higher Tier option for learners who are a small number of marks below the grade 3/4 boundary. Learners must be entered for either the Foundation Tier or the Higher Tier.

3d. Assessment availability

There will be one examination series available each year in May/June to **all** learners.

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

This specification will be certificated from the June 2018 examination series onwards.

3e. Retaking the qualification

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

They retake all the papers of the relevant tier to be awarded the qualification.

3f. Assessment of extended response

Extended response questions which are marked using a level of response mark scheme are included in all externally assessed papers. These are indicated in papers and mark schemes by an asterisk (*). Extended response questions provide learners with the opportunity to demonstrate their ability to construct and develop a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.

3g. 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 GCSE (9–1) course. The emphasis of synoptic assessment is to encourage the development of the understanding of the subject as a discipline. Paper 2 and Paper 4 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 or 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.

3h. Calculating qualification results

A learner's overall qualification grade for OCR GCSE (9–1) in Biology A (Gateway Science) will be calculated by adding together their marks from the two papers taken to give their total weighted mark. This mark will then be compared to the qualification level grade boundaries for the entry option taken by the learner and 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 these processes, together with the deadlines, can be found in the OCR *Admin Guide and Entry Codes: 14–19 Qualifications*, which can be downloaded from the OCR website: www.ocr.org.uk

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 a GCSE (9–1) in Biology A (Gateway Science) must be entered for one of the following entry options:

Entry option		Components		
Entry code	**Title**	**Code**	**Title**	**Assessment type**
J247 F	Biology A (Gateway Science) (Foundation Tier)	01	Paper 1 (Foundation Tier)	External assessment
		02	Paper 2 (Foundation Tier)	External assessment
J247 H	Biology A (Gateway Science) (Higher Tier)	03	Paper 3 (Higher Tier)	External assessment
		04	Paper 4 (Higher Tier)	External assessment

Each learner must be entered for either the Foundation Tier **or** the Higher Tier only. They cannot be entered for a combination of tiers.

4b. Special consideration

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 publication *A guide to the special consideration process*.

4c. External assessment arrangements

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

4d. Results and certificates

Grade Scale

GCSE (9–1) qualifications are graded on the scale: 9–1, where 9 is the highest. Learners who fail to reach the minimum standard of 1 will be Unclassified (U). Only subjects in which grades 9 to 1 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 each entry option.

Until certificates are issued, results are deemed to be provisional and may be subject to amendment.

A learner's final result(s) will be recorded on an OCR certificate. The qualification title will be shown on the certificate as 'OCR Level 1/2 GCSE (9–1) in Biology A (Gateway Science)'.

4e. Post-results services

A number of post-results services are available:

- **Enquiries about results** – If you think there may be something wrong with a learner's results, centres may submit an enquiry about results
- **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 JCQ publication *Suspected Malpractice in Examinations and Assessments: Policies and Procedures*.

5 Appendices

5a. Overlap with other qualifications

There is a small degree of overlap between the content of this specification and those for GCSE (9–1) in Combined Science A (Gateway Science), GCSE (9–1) in Chemistry A (Gateway Science) and GCSE (9–1) in Physics A (Gateway Science) courses. The links between the specifications may allow for some co-teaching, particularly in the area of working scientifically.

5b. Accessibility

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.*

The GCSE (9–1) 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. Units in science

It is expected that learners will show understanding of the biological quantities and corresponding units, SI base and derived units listed below.

They will be able to use them in qualitative work and calculations. These units and their associated quantities are dimensionally independent.

SI base units		
Physical quantity	Unit	Unit
Length	metre	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Current	ampere	A
Amount of a substance	mole	mol

SI derived units		
Physical quantity	Unit(s)	Unit(s)
Area	squared metre	m^2
Volume	cubic metre; litre; cubic decimetre	m^3; *l;* dm^3
Density	kilogram per cubic metre	kg/m^3
Temperature	degree Celsius	^oC
Pressure	pascal	Pa
Specific heat capacity	joule per kilogram per degree Celsius	$J/kg/^oC$
Specific latent heat	joule per kilogram	J/kg
Speed	metre per second	m/s
Force	newton	N
Gravitational field strength	newton per kilogram	N/kg
Acceleration	metre per squared second	m/s^2

SI derived units		
Frequency	hertz	Hz
Energy	joule	J
Power	watt	W
Electric charge	coulomb	C
Electric potential difference	volt	V
Electric resistance	ohm	Ω
Magnetic flux density	tesla	T

5d. Working scientifically

The idea that science progresses through a cycle of hypothesis, experimentation, observation, development and review is encompassed in this section. It covers aspects of scientific thinking and aims to develop the scientific skills and conventions, fundamental to the study of science. The section includes understanding of theories and applications of science, the practical aspects of scientific experimentation, and objective analysis and evaluation. This will enable learners to develop an understanding of the processes and methods of science and, through consideration of the different types of scientific enquiry, learners will become equipped to answer scientific questions about the world around them. Learners will also develop and learn to apply skills in observation, modelling and problem-solving, with opportunities for these skills to be shown through links to specification content. Scientific-based claims require evaluative skills and these are also developed in this section with opportunities for contextual development highlighted. Learners should learn to evaluate through critical analysis of methodology, evidence and conclusions, both qualitatively and quantitatively.

Working scientifically is split into concepts (WS1) and practical skills (WS2). Both of these will be assessed in written examinations and WS2 may also be assessed through practical activities.

WS1: Working scientifically assessed in written examinations

Summary

The concepts and skills in this section can be assessed in written examinations. There are references to specific apparatus and methods throughout the content of the specification. WS1 is split into four parts.

WS1.1 Development of scientific thinking

Assessable Content		
Learning outcomes		**To include**
WS1.1a	understand how scientific methods and theories develop over time	new technology allowing new evidence to be collected and changing explanations as new evidence is found
WS1.1b	use models to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts	representational, spatial, descriptive, computational and mathematical models
WS1.1c	understand the power and limitations of science	how developments in science have led to increased understanding and improved quality of life and questions and problems that science cannot currently answer
WS1.1d	discuss ethical issues arising from developments in science	
WS1.1e	explain everyday and technological applications of science	
WS1.1f	evaluate associated personal, social, economic and environmental implications	
WS1.1g	make decisions based on the evaluation of evidence and arguments	
WS1.1h	evaluate risks both in practical science and the wider societal context	perception of risk in relation to data and consequences
WS1.1i	recognise the importance of peer review of results and of communicating results to a range of audiences	

WS1.2 Experimental skills and strategies

Assessable Content		
Learning outcomes		**To include**
WS1.2a	use scientific theories and explanations to develop hypotheses	
WS1.2b	plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena	
WS1.2c	apply a knowledge of a range of techniques, instruments, apparatus, and materials to select those appropriate to the experiment	
WS1.2d	recognise when to apply a knowledge of sampling techniques to ensure any samples collected are representative	
WS1.2e	evaluate methods and suggest possible improvements and further investigations	

WS1.3 Analysis and evaluation

Assessable Content		
Learning outcomes		**To include**
	Apply the cycle of collecting, presenting and analysing data, including:	
WS1.3a	presenting observations and other data using appropriate methods	methods to include descriptive, tabular diagrammatic and graphically
WS1.3b	translating data from one form to another	
WS1.3c	carrying out and representing mathematical and statistical analysis	statistical analysis to include arithmetic means, mode, median
WS1.3d	representing distributions of results and make estimations of uncertainty	
WS1.3e	interpreting observations and other data	data presentations to include verbal, diagrammatic, graphical, symbolic or numerical form interpretations to include identifying patterns and trends, making inferences and drawing conclusions
WS1.3f	presenting reasoned explanations	relating data to hypotheses
WS1.3g	being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility	
WS1.3h	identifying potential sources of random and systematic error	
WS1.3i	communicating the scientific rationale for investigations, methods used, findings and reasoned conclusions	presentations through paper-based presentations using diagrammatic, graphical, numerical and symbolic forms

WS1.4 Scientific vocabulary, quantities, units, symbols and nomenclature

Assessable Content		
Learning outcomes		**To include**
WS1.4a	use scientific vocabulary, terminology and definitions	
WS1.4b	recognise the importance of scientific quantities and understand how they are determined	
WS1.4c	use SI units and IUPAC chemical nomenclature unless inappropriate	base units & derived units (Appendix 5c)
WS1.4d	use prefixes and powers of ten for orders of magnitude	tera, giga, mega, kilo, deci, centi, milli, micro and nano
WS1.4e	interconvert units	
WS1.4f	use an appropriate number of significant figures in calculation	

WS2: Working scientifically skills demonstrated

Summary

A range of practical experiences are a vital part of a scientific study at this level. A wide range of practical skills will be addressed throughout the course, skills which are required for the development of investigative skills. Learners should be given the opportunity to practise their practical skills, which will also prepare them for the written examinations.

For further details of the practical activity requirement see Topic 7.

Practical skills to be developed		
Learning outcomes		**To include**
WS2a	carry out experiments	due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations, and following written instructions
WS2b	make and record observations and measurements using a range of apparatus and methods	keeping appropriate records
WS2c	presenting observations using appropriate methods	methods to include descriptive, tabular diagrammatic and graphically
WS2d	communicating the scientific rationale for investigations, methods used, findings and reasoned conclusions	presentations through paper-based and electronic reports and presentations using verbal, diagrammatic, graphical, numerical and symbolic forms

5e. Mathematical skills requirement

In order to be able to develop their skills, knowledge and understanding in GCSE (9–1) in Biology A (Gateway Science), 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 table of coverage below.

The questions and tasks used to target mathematical skills will be at a level of demand that is appropriate to GCSE (9–1) Biology.

In the Foundation Tier question papers, the questions that assess mathematical skills will not be of a lower demand than that which is expected of learners at Key Stage 3, as outlined in the Department for Education's document "*Mathematics programme of study: key stage 3*".

In the Higher Tier question papers, the questions that assess mathematical skills will not be lower than that of question and tasks in assessment for the Foundation Tier in a GCSE qualification in Mathematics.

The assessment of quantitative skills would include at least 10% GCSE (or above) mathematical skills at the appropriate tier for biology.

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

All mathematical content will be assessed within the lifetime of the specification.

This list of examples is not exhaustive and is not limited to GCSE examples. These skills could be developed in other areas of specification content as indicated in the opportunities to cover column.

The mathematical skills required for the GCSE (9–1) in Biology (B), Chemistry (C), Physics (P) and Combined Science (CS) are shown in the table below.

	Mathematical skills	Subject			
M1	**Arithmetic and numerical computation**				
a	Recognise and use expressions in decimal form	B	C	P	CS
b	Recognise and use expressions in standard form	B	C	P	CS
c	Use ratios, fractions and percentages	B	C	P	CS
d	Make estimates of the results of simple calculations	B	C	P	CS
M2	**Handling data**				
a	Use an appropriate number of significant figures	B	C	P	CS
b	Find arithmetic means	B	C	P	CS
c	Construct and interpret frequency tables and diagrams, bar charts and histograms	B	C	P	CS
d	Understand the principles of sampling as applied to scientific data	B			
e	Understand simple probability	B			
f	Understand the terms mean, mode and median	B		P	CS
g	Use a scatter diagram to identify a correlation between two variables	B		P	CS
h	Make order of magnitude calculations	B	C	P	CS
M3	**Algebra**				
a	Understand and use the symbols: =, <, <<, >>, >, ∝, ~	B	C	P	CS
b	Change the subject of an equation		C	P	CS
c	Substitute numerical values into algebraic equations using appropriate units for physical quantities		C	P	CS
d	Solve simple algebraic equations	B		P	CS
M4	**Graphs**				
a	Translate information between graphical and numeric form	B	C	P	CS
b	Understand that y=mx+c represents a linear relationship	B	C	P	CS
c	Plot two variables from experimental or other data	B	C	P	CS
d	Determine the slope and intercept of a linear graph	B	C	P	CS
e	Draw and use the slope of a tangent to a curve as a measure of rate of change		C		CS
f	Understand the physical significance of area between a curve and the x-axis and measure it by counting squares as appropriate			P	CS
M5	**Geometry and trigonometry**				
a	Use angular measures in degrees			P	CS
b	Visualise and represent 2D and 3D forms including two dimensional representations of 3D objects		C	P	CS
c	Calculate areas of triangles and rectangles, surface areas and volumes of cubes.	B	C	P	CS

5f. 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: https://www.ase.org.uk

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

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

Where an employer has adopted model risk assessments an individual school or college then has to review them, to see if there is a need to modify or adapt them in some way to suit the particular conditions of the establishment.

Such adaptations might include a reduced scale of working, deciding that the fume cupboard provision was inadequate or the skills of the learners were insufficient to attempt particular activities safely. The significant findings of such risk assessment should then be recorded in a '*point of use text*', for example on schemes of work, published teachers guides, work sheets, etc. There is no specific legal requirement that detailed risk assessment forms should be completed for each practical activity, although a minority of employers may require this.

Where project work or investigations, sometimes linked to work-related activities, are included in specifications this may well lead to the use of novel procedures, chemicals or microorganisms, which are not covered by the employer's model risk assessments. The employer should have given guidance on how to proceed in such cases. Often, for members, it will involve contacting CLEAPSS[1]

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

YOUR CHECKLIST

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

- ☐ Bookmark **ocr.org.uk/gcsegatewaybiology** for all the latest resources, information and news on GCSE (9-1) Gateway Science Biology A
- ☐ Be among the first to hear about support materials and resources as they become available – register for Gateway Science Biology A updates at **ocr.org.uk/updates**
- ☐ Find out about our professional development at **cpdhub.ocr.org.uk**
- ☐ View our range of skills guides for use across subjects and qualifications at **ocr.org.uk/skillsguides**
- ☐ Discover our new online past paper service at **ocr.org.uk/examcreator**
- ☐ Learn more about Active Results at **ocr.org.uk/activeresults**
- ☐ Join our Gateway Science Biology A social network community for teachers at **social.ocr.org.uk**

Download high-quality, exciting and innovative GCSE (9-1) Gateway Science Biology A resources from ocr.org.uk/gcsegatewaybiology

Resources and support for our GCSE (9-1) Gateway Science Biology A qualification, developed through collaboration between our Biology Subject Specialists, teachers and other subject experts, are available from our website. You can also contact our Biology Subject Specialists who can give you specialist advice, guidance and support.

Meet the team at ocr.org.uk/scienceteam and contact them at:
01223 553998
science@ocr.org.uk
@OCR_science

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

Biology Community

The social network is a free platform where teachers can engage with each other – and with us – to find and offer guidance, discover and share ideas, best practice and a range of Biology support materials. To sign up, go to social.ocr.org.uk

facebook.com/ocrexams
linkedin.com/company/ocr
@OCR_science
youtube.com/ocrexams

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