OXFORD AQA
INTERNATIONAL QUALIFICATIONS

International GCSE

Biology

(9201) Specification

For teaching from September 2016 onwards

For exams May/June 2018 onwards

For teaching and examination outside the United Kingdom

Contents

Key for symbol

Most of the subject content is common with and co-teachable with OxfordAQA International GCSE Combined Science (9204). Content that is only applicable to biology is indicated by B either next to the topic heading where it applies to the whole topic or immediately preceding each paragraph or bullet point as applicable.

Are you using the latest version of this specification?

- You will always find the most up-to-date version of this specification on our website at **oxfordaqa.com/9201**
- We will write to you if there are significant changes to the specification.

1 Introduction

1.1 Why choose OxfordAQA International GCSEs?

Our International qualifications enable schools that follow a British curriculum to benefit from the best education expertise in the United Kingdom (UK).

Our International GCSEs offer the same rigour and high quality as GCSEs in the UK and are relevant and appealing to students worldwide. They reflect a deep understanding of the needs of teachers and schools around the globe and are brought to you by Oxford University Press and AQA, the UK's leading awarding body.

Providing valid and reliable assessments, these qualifications are based on over 100 years of experience, academic research, and international best practice. They have been independently validated as being to the same standard as the qualifications accredited by the UK examinations regulator, Ofqual. They reflect the latest changes to the British system, enabling students to progress to higher education with up-to-date qualifications.

You can find out about OxfordAQA at **oxfordaqa.com**

1.2 Why choose our International GCSE Biology?

In developing this specification we have consulted widely with teachers and science advisers to produce content and assessments that will both stimulate students' interest in and enthusiasm for biology and provide an excellent grounding for further study. This specification contains a broad range of topics that are designed to engage students whilst providing the knowledge and understanding required for progression to Level 3 qualifications.

Biology is an enquiry-based discipline involving practical and investigational skills as well as knowledge. The specification emphasises scientific knowledge, the application of science and the scientific process. Section 3 gives the fundamental ideas behind scientific enquiry that should be delivered through teaching of the content. The experimental and investigative skills that will be assessed in this specification are listed in Section 6.1. There are a number of required practicals identified in the specification, which students will need to cover as part of the content of the specification. These practicals will be assessed during the lifetime of the specification. These are summarised in Section 6.2.

The terminal assessment model is designed to ensure the maximum amount of time for teaching.

You can find out about all our International GCSE Biology qualifications at **oxfordaqa.com/science**

1.3 Recognition

OxfordAQA meet the needs of international students. They are an international alternative and comparable in standard to the Ofqual regulated qualifications offered in the UK.

Our qualifications have been independently benchmarked by UK ENIC, the UK national agency for providing expert opinion on qualifications worldwide. They have confirmed they can be considered 'comparable to the overall GCE A-level and GCSE standard offered in the UK'.

To read their report and see the latest list of universities who have stated they accept these international qualifications, visit **oxfordaqa.com/recognition**

1.4 The Oxford International Programme learner attributes

In order to equip students with the skills they need for success both now and in the future, we have worked with Oxford University Press to create the Oxford International Programme. This combines the Oxford International Curriculum with OxfordAQA qualifications, creating an integrated offer for international schools, from Early Years to A-level.

At its core we have introduced the Oxford International Programme learner attributes – the skills and competencies that enable our students to thrive academically, socially and personally.

The learner attributes, alongside our focus on demonstrating higher order critical thinking skills, ensure that students are equipped to get the grades that will take them places, and build the skills they need to be successful when they get there.

1.5 Support and resources to help you teach

We know that support and resources are vital for your teaching and that you have limited time to find or develop good quality materials. That's why we've worked with experienced teachers to provide resources that will help you confidently plan, teach and prepare for exams.

Teaching resources

You will have access to:

- sample schemes of work to help you plan your course with confidence
- training courses to help you deliver our qualifications
- student textbooks that have been checked and approved by us
- engaging worksheets and activities developed by teachers, for teachers
- command words with exemplars
- science vocabulary with definitions
- a handbook to support practical work.

Preparing for exams

You will have access to the support you need to prepare for our exams, including:

- specimen papers and mark schemes
- exemplar student answers with examiner commentaries
- a searchable bank of past AQA exam questions mapped to these new International qualifications.

Analyse your students' results with Enhanced Results Analysis (ERA)

After the first examination series, you can use this tool to see which questions were the most challenging, how the results compare to previous years and where your students need to improve. ERA, our free online results analysis tool, will help you see where to focus your teaching.

Information about results, including maintaining standards over time, grade boundaries and our post-results services, will be available on our website in preparation for the first examination series.

Help and support

Visit our website for information, guidance, support and resources at **oxfordaqa.com/9201**

You can contact the subject team directly at **info@oxfordaqa.com** or call us on +44 (0)161 696 5995 (option 1 and then 1 again).

Please note: We aim to respond to all email enquiries within two working days.

Our UK office hours are Monday to Friday, 8am – 5pm.

2 Specification at a glance

The title of the qualification is:

- OxfordAQA International GCSE Biology.

This qualification is linear. Linear means that students will sit all their exams at the end of the course.

Exams will be available May/June and in November.

The guided learning hours (GLH) for this qualification are 120–140. This figure is for guidance only and may vary according to local practice and the learner's prior experience of the subject.

2.1 Subject content

Organisation

All organisms are constituted of one or more cells. Multicellular organisms have cells that are differentiated according to their function. All the basic functions of life are the result of what happens inside the cells which make up an organism. Growth is the result of multiple cell divisions.

Topics covered are:

- cell structure
- principles of organisation
- animal tissues, organs and organ systems
- plant tissues, organs and systems
- transport in cells.

Bioenergetics

Food provides materials and energy for organisms to carry out the basic functions of life and to grow. Some plants and bacteria are able to use energy from the Sun to generate complex food molecules. Animals obtain energy by breaking down complex food molecules and are ultimately dependent on green plants for energy.

Topics covered are:

- photosynthesis
- exchange and transport in plants B
- circulation
- digestion
- breathing
- respiration.

Ecology

Materials including carbon and water are continually recycled by the living world, being released through respiration of animals, plants and decomposing microorganisms and taken up by plants in photosynthesis. All species live in ecosystems composed of complex communities of animals and plants dependent on each other and that are adapted to particular conditions, both abiotic and biotic.

Topics covered are:

- energy transferred in ecosystems
- adaptations, interdependence and competition
- decay and the carbon cycle
- the effect of human interaction on ecosystems and biodiversity. B

Organisms' interaction with the environment

Changes in environmental conditions can result in responses from an organism which protect the organism from harm and support maintenance of the species. Such responses may impact the internal stability of the organism or promote certain behaviours to protect it.

Topics covered are:

- the human nervous and hormonal systems
- principles of homeostasis
- control of water and ion content of the body B
- temperature control
- control of blood glucose
- behaviour
- infection and response.

Inheritance

Genetic information in a cell is held in the chemical DNA. Genes determine the development and structure of organisms. In asexual reproduction all the genes in the offspring come from one parent. In sexual reproduction half of the genes come from each parent.

Topics covered are:

- reproduction
- cell division
- genetic variation
- genetic disorders
- genetic manipulation.

Variation and evolution

All life today is directly descended from a universal common ancestor that was a simple single-celled organism. Over countless generations changes resulted from natural diversity within a species which makes possible the selection of those individuals best suited to survive under certain conditions. Species not able to respond sufficiently to changes in their environment are at risk of becoming extinct.

Topics covered are:

- variation
- natural selection.

2.2 Assessments

OxfordAQA International GCSE Biology is linear, with two question papers to be taken in the same examination series.

Paper 1	+	Paper 2
What's assessed Content from any part of the specification may be assessed.		**What's assessed** Content from any part of the specification may be assessed.
How it's assessed Written exam: 1 hour 30 minutes 90 marks		**How it's assessed** Written exam: 1 hour 30 minutes 90 marks
Questions Structured and open questions.		**Questions** Structured and open questions.

3 Subject content

Through the teaching of this biology syllabus, students will develop knowledge and understanding of the subject content of biology, the practices of science and how science as a discipline develops. Students will develop their ability to work as a scientist.

Working as a scientist involves being able to observe, question, hypothesise and carry out various types of scientific enquiry to further scientific knowledge, and to be able to use models and arguments to support explanations and decision making. It also involves following established procedures to ensure that new scientific knowledge can be validated.

Working this way requires knowledge and understanding of the practices of science and how science as a discipline develops.

Knowledge of the subject content in isolation does **not** provide the knowledge, understanding and skills required for progression to higher qualifications or develop the knowledge, understanding and skills required for students to be future scientists or scientifically literate citizens.

There are three dimensions to working as a scientist:

- Subject content
- The practices of science
- How science as a discipline develops.

Subject content

The established facts, concepts, ideas and theories.

The assessed subject content is presented as a series of topic areas listing the statements students need to know, understand and apply. Expansion of the content and clarification of what may be examined is given in *italics*.

The practices of science

How observation and experimentation is carried out to obtain evidence. The assessment requirements are detailed in the specification appendices 6.1 and 6.2.

Students should develop an understanding of how the following elements relate to the subject content and practices of science.

Students should be able to:

- suggest, describe and explain experimental and investigative procedures
- justify the choice of experimental or investigative procedure and the use of apparatus
- identify possible hazards, the risks associated with these hazards, and methods of minimising the risks
- recognise and explain the need to manipulate and control variables, including the use of control groups where necessary
- assess whether sufficient measurements have been taken with appropriate precision, and appreciate when it is appropriate to calculate a mean
- recognise and identify the causes of anomalous results and suggest what should be done about them
- present, analyse and interpret data in tabular and graphical forms, identifying patterns and correlations (which may be causal or non-causal)
- recognise and identify the causes of random and systematic errors

- evaluate data, considering its validity, repeatability and reproducibility in supporting conclusions
- evaluate working methods, suggesting advantages and disadvantages of approaches used.

How science as a discipline develops

The defining features that characterise the nature of the subject and how new scientific knowledge is established.

The defining features of how science knowledge and understanding develops over time:

- Predictions are tested to support or refute a new scientific idea or explanation.
- Scientific claims are supported by evidence and scientific reasoning, and should be able to be confirmed by other scientists.
- Evidence and creative thinking is used to develop new scientific ideas and explanations.
- Different conclusions may be drawn from available evidence and can be influenced by personal background, experience or interests.
- New technologies and practical techniques can lead to new investigations and discoveries, and advance scientific knowledge and understanding.
- New evidence can lead to new lines of enquiry and changes in scientific ideas and explanations.
- Models are used to support scientific explanations with limits to what they can and cannot explain.
- Accepted scientific ideas and explanations can take a long time to be abandoned even if new evidence disagrees with predictions based upon them.
- Science often involves collaboration in interdisciplinary teams, often from several countries.

The scientific terms used in this specification are clearly defined by the ASE in *The Language of Measurement: Terminology used in school science investigations* (Association for Science Education, 2010).

Teachers should ensure that they and their students are familiar with these terms. Definitions of the terms will **not** be required in assessments, but students will be expected to use them correctly.

3.1 Organisation

All organisms are constituted of one or more cells. Multicellular organisms have cells that are differentiated according to their function. All the basic functions of life are the result of what happens inside the cells which make up an organism. Growth is the result of multiple cell divisions.

3.1.1 Cell structure

a. Most animal cells (eukaryotic cells) have the following parts:

- a nucleus, which controls the activities of the cell
- cytoplasm, in which most of the chemical reactions take place
- a cell membrane, which controls the passage of substances into and out of the cell
- mitochondria, which is where most energy is released in respiration
- ribosomes, which is where protein synthesis occurs.

b. In addition to the above, plant cells (eukaryotic cells) often have:

- chloroplasts, which absorb light energy to make food
- a permanent vacuole filled with cell sap.

Plant and algal cells also have a cell wall made of cellulose, which strengthens the cell.

c. A bacterial cell (prokaryotic cells) consists of cytoplasm and a membrane surrounded by a cell wall; the genes are not in a distinct nucleus; some of the genes are located in circular structures called plasmids.

d. Cells may be specialised to carry out a particular function.

Students should be able, when provided with appropriate information, to relate the structure of different types of cell to their function in a tissue, an organ, or the whole organism.

3.1.2 Principles of organisation

a. Large multicellular organisms develop systems for exchanging materials. During the development of a multicellular organism, cells differentiate so that they can perform different functions.

b. A tissue is a group of cells with similar structure and function.

c. Organs are made of tissues. One organ may contain several tissues.

d. Organ systems are groups of organs that perform a particular function.

Students should develop an understanding of size and scale in relation to cells, tissues, organs and systems.

3.1.3 Animal tissues, organs and systems

a. Examples of animal tissues include:

- muscular tissue, which can contract to bring about movement
- glandular tissue, which can produce substances such as enzymes and hormones
- epithelial tissue, which covers some parts of the body.

b. An example of an animal organ is the stomach, which contains:

- muscular tissue, to allow contents to move through the digestive system
- glandular tissue, to produce digestive juices
- epithelial tissue, to cover the outside and the inside of the stomach.

c. An example of an animal organ system is the digestive system, a system in which humans and other mammals exchange substances with the environment. The human digestive system includes:

- glands, such as the pancreas and salivary glands, which produce digestive juices
- the stomach and small intestine, where digestion occurs
- the liver, which produces bile
- the small intestine, where the absorption of soluble food occurs
- the large intestine, where water is absorbed from the undigested food, producing faeces.

3.1.4 Plant tissues, organs and systems

a. Examples of plant tissues include:

- epidermal tissues, which cover the plant
- palisade mesophyll, which carries out photosynthesis
- spongy mesophyll, which has air spaces to facilitate diffusion of gases
- xylem and phloem, which transport substances around the plant.

b. Plant organs include stems, roots and leaves.

Details of the internal structure of these organs are limited to the leaf and to the position of the xylem and phloem in a dicotyledonous primary root and primary stem.

3.1.5 Transport in cells

The movement of substances into and out of cells.

a. Diffusion is the spreading of the particles of any substance in solution, or particles of a gas, resulting in a net movement from an area of higher concentration to an area of lower concentration. The greater the difference in concentration, the faster the rate of diffusion.

b. Dissolved substances can move into and out of cells by diffusion.

c. Oxygen required for respiration passes through cell membranes by diffusion.

d. Osmosis is the diffusion of water from a dilute to a more concentrated solution through a partially permeable membrane that allows the passage of water molecules.

e. Differences in the concentrations of the solutions inside and outside a cell cause water to diffuse into or out of the cell by osmosis.

Students should be familiar with experiments related to diffusion and osmosis as well as the terms isotonic, hypotonic, hypertonic, turgor and plasmolysis.

Required practical:
Investigate the effect of different concentrations of solutions separated by a partially permeable membrane. B

f. Substances are sometimes absorbed against a concentration gradient. This requires the use of energy from respiration. The process is called active transport.

g. Active transport enables plants to absorb ions from very dilute solutions, eg by root hair cells. In animals, sugar may be absorbed from low concentrations in the intestine and from low concentrations in the kidney tubules.

h. A single-celled organism has a relatively large surface area to volume ratio. All the necessary exchanges occur across its surface membrane.

   The increased size and complexity of an organism increases the difficulty of exchanging materials.

i. In multicellular organisms many organ systems are specialised for exchanging materials. The effectiveness of an exchange surface is increased by:

   - having a large surface area that is thin, to provide a short diffusion path
   - (in animals) having an efficient blood supply
   - (in animals, for gaseous exchange) being ventilated.

Students should be able to explain how the small intestine and lungs in mammals, and the roots and leaves in plants, are adapted for exchanging materials.

j. Gas and solute exchange surfaces in humans and other organisms are adapted to maximise effectiveness.

Students should be able to explain how gas and solute exchange surfaces are adapted to maximise effectiveness.

3.2 Bioenergetics

Food provides materials and energy for organisms to carry out the basic functions of life and to grow. Some plants and bacteria are able to use energy from the Sun to generate complex food molecules. Animals obtain energy by breaking down complex food molecules and are ultimately dependent on green plants for energy.

3.2.1 Photosynthesis

a. Photosynthesis is represented by the equations:

$$\text{carbon dioxide + water} \xrightarrow{\text{light}} \text{glucose + oxygen}$$

$$6CO_2 + 6H_2O \xrightarrow{\text{light}} C_6H_{12}O_6 + 6O_2$$

b. During photosynthesis:

- light is absorbed by a green substance called chlorophyll, which is found in chloroplasts in some plant cells and in algae
- light is used to convert carbon dioxide (from the air) and water (from the soil) into sugar (glucose)
- oxygen is released as a by-product.

c. The rate of photosynthesis may be limited by:

- low temperature
- shortage of carbon dioxide
- shortage of light.

These factors interact and any one of them may be the factor that limits photosynthesis.

Students should be able to relate the principle of limiting factors to the economics of enhancing the following conditions in greenhouses:

- *temperature*
- *carbon dioxide concentration*
- *light intensity.*

Required practical:
Investigate how variables affect the rate of photosynthesis.

d. The glucose produced in photosynthesis may be used as a source of chemical energy or converted to larger molecules for storage and use later. The glucose can be:

- used for respiration
- converted into insoluble starch for storage
- used to produce fat or oil for storage
- used to produce cellulose, which strengthens the cell wall
- used to produce proteins.

e. To produce proteins, plants also use nitrate ions that are absorbed from the soil.

3.2.2 Exchange and transport in plants B

a. In flowering plants:

- carbon dioxide enters leaves by diffusion through the stomata
- most of the water and mineral ions are absorbed by roots.

b. The surface area of roots is increased by root hairs, and the surface area to volume ratio of leaves is increased by the flattened shape and internal air spaces.

c. Plants have stomata to obtain carbon dioxide from the atmosphere and to remove oxygen produced in photosynthesis. Stomata also help to control the rate of water loss.

d Plants mainly lose water vapour from their leaves. Most of the loss of water vapour takes place through the stomata.

- Evaporation is more rapid in hot, dry and windy conditions.
- If plants lose water faster than it is replaced by the roots, the stomata can close to prevent wilting.

e. The size of stomata is controlled by guard cells, which surround them.

f. Flowering plants have separate transport systems:

- xylem tissue transports water and mineral ions from the roots to the stem and leaves
- the movement of water from the roots through the xylem and out of the leaves is called the transpiration stream
- phloem tissue carries dissolved sugars from the leaves to the rest of the plant, including the growing regions and the storage organs. This process is called translocation
- the structure of the xylem and the phloem is related to its function.

3.2.3 Circulation in humans

a. Substances are transported from where they enter the body to the cells, or from the cells to where they are removed from the body, by the circulatory system (the heart, the blood vessels and the blood).

b. The heart is an organ that pumps blood around the body in a double circulatory system. Much of the wall of the heart is made from muscle tissue.

c. The heart has four main chambers (right and left atria and right and left ventricles).

d. The natural resting heart rate is controlled by a group of cells that act as a pacemaker, located in the right atrium. Artificial pacemakers are electrical devices used to correct irregularities in the heart rate. B

e. In coronary heart disease, layers of fatty material build up inside the coronary arteries and narrow them. This reduces the flow of blood through the coronary arteries, resulting in a lack of oxygen for the heart muscle. Stents are used to keep the coronary arteries open. B

f. In some people heart valves may become faulty. There are two main faults – the heart valve tissue might stiffen, preventing the valve from opening fully, or the heart valve might develop a leak. B

Faulty heart valves can be replaced using:

- biological valves – valves from humans or other mammals
- mechanical valves.

g. Artificial hearts are occasionally used to keep patients alive whilst waiting for a heart transplant, or to allow the heart to rest as an aid to recovery. B

h. Blood enters the atria of the heart. The atria contract and force blood into the ventricles. The ventricles contract and force blood out of the heart. Valves in the heart ensure that blood flows in the correct direction.

Knowledge of the names of the heart valves is not required.

i. Blood flows from the heart to the organs through arteries and returns through veins. There are two separate circulation systems, one for the lungs and one for all other organs of the body.

Knowledge of the blood vessels associated with the heart is limited to aorta, vena cava, pulmonary artery, pulmonary vein and coronary arteries.

j. Arteries have thick walls containing muscle and elastic fibres. Veins have thinner walls and often have valves to prevent back-flow of blood.

k. In the organs, blood flows through very narrow, thin-walled blood vessels called capillaries. Substances needed by the cells in body tissues pass out of the blood and substances produced by the cells pass into the blood, through the walls of the capillaries.

l. Blood is a tissue consisting of a fluid called plasma, in which the white blood cells, platelets and red blood cells are suspended.

m. Blood plasma transports:

- carbon dioxide from the organs to the lungs
- soluble products of digestion from the small intestine to other organs
- urea from the liver to the kidneys.

n. Red blood cells have no nucleus. They are packed with a red pigment called haemoglobin. Red blood cells transport oxygen from the lungs to the organs. In the lungs haemoglobin combines with oxygen to form oxyhaemoglobin. In other organs oxyhaemoglobin splits up into haemoglobin and oxygen.

o. White blood cells have a nucleus. They form part of the body's defence system against microorganisms.

p. Platelets are small fragments of cells. They have no nucleus. Platelets help blood to clot at the site of a wound.

q. Blood clotting is a series of enzyme-controlled reactions, resulting in the change of fibrinogen to fibrin, which forms a network of fibers trapping blood cells and forming a clot.

r. Antigens are proteins on the surface of cells.

s. In organ transplants a diseased organ is replaced with a healthy one from a donor. The recipient's antibodies may attack the antigens on the donor organ as they do not recognise them as part of the recipient's body. B

To prevent rejection of the transplanted organ: B

- a donor organ with a 'tissue-type' similar to that of the recipient is used
- the recipient is treated with drugs that suppress their immune system.

Students should be able to evaluate the advantages and disadvantages of treating organ failure by mechanical devices or transplant. B

t. There are four main types of human blood: O, A, B and AB. Blood group O is the universal donor. B

Students should understand: B

- *the need for blood typing*
- *the ABO compatibility table.*

3.2.4 Digestion

a. Starch (a carbohydrate), proteins and fats are insoluble. They are broken down into soluble substances so that they can be absorbed into the bloodstream in the wall of the small intestine. In the large intestine much of the water mixed with the food is absorbed into the bloodstream. The indigestible food which remains makes up the bulk of the faeces. Faeces leave the body via the anus.

Students should be able to recognise the following on a diagram of the digestive system: salivary glands, oesophagus, stomach, liver, gall bladder, pancreas, duodenum, small intestine, large intestine, anus.

b. Enzymes help the breakdown of food in the digestive system.

- Enzymes are large proteins that act as biological catalysts. Catalysts increase the rate of chemical reactions and are utilized in the digestive process to speed up the breakdown of large molecules to small molecules for absorption into the bloodstream.
- The shape of an enzyme is vital for the enzyme's function. High temperatures denature the enzyme, changing the shape of the active site.
- Different enzymes work best at different pH values.
- Some enzymes work outside the body cells. The digestive enzymes are produced by specialised cells in glands and in the lining of the gut. The enzymes then pass out of the cells into the gut, where they come into contact with food molecules. They catalyse the breakdown of large molecules into smaller molecules.

Required practical:
Investigate how different temperatures, and pH affect the rate of digestion. B

c. Digestive enzymes.

- The enzyme amylase is produced in the salivary glands, the pancreas and the small intestine. Amylase catalyses the breakdown of starch into sugars in the mouth and small intestine.
- Protease enzymes are produced by the stomach, the pancreas and the small intestine. These enzymes catalyse the breakdown of proteins into amino acids in the stomach and the small intestine.
- Lipase enzymes are produced by the pancreas and small intestine. These enzymes catalyse the breakdown of lipids (fats) into fatty acids and glycerol in the small intestine.
- The stomach also produces hydrochloric acid. The enzymes in the stomach work most effectively in acid conditions.
- The liver produces bile, which is stored in the gall bladder before being released into the small intestine. Bile neutralises the acid that was added to food in the stomach. This provides alkaline conditions in which enzymes in the small intestine work most effectively.
- Bile also emulsifies fats (breaks large drops of fats into smaller droplets). This increases the surface area of fats for lipase enzymes to act upon.

- Some microorganisms produce enzymes that pass out of the cells. These enzymes have many uses in the home and in industry. B

Students should be able to give examples of some enzymes used in the home and industry and relate data to the properties of enzymes. B

3.2.5 Breathing

a. The respiratory (breathing) system takes air into and out of the body so that oxygen from the air can diffuse into the bloodstream and carbon dioxide can diffuse out of the bloodstream into the air. The lungs are in the upper part of the body (thorax), protected by the ribcage and separated from the lower part of the body (abdomen) by the diaphragm.

Students should be able to recognise the following on a diagram of the respiratory system: ribs, intercostal muscles, diaphragm, lungs, trachea, bronchi, bronchioles, alveoli.

b. To inhale:

- the intercostal muscles contract, pulling the ribcage upwards
- at the same time the diaphragm muscles contract, causing the diaphragm to flatten
- these two movements cause an increase in the volume of the thorax
- the consequent decrease in pressure to below that of the air surrounding the body results in atmospheric air entering the lungs.

To exhale:

- the intercostal muscles relax, allowing the rib cage to move downwards
- at the same time the diaphragm muscles relax, allowing the diaphragm to resume its domed shape
- these two movements cause a reduction in the volume of the thorax
- the consequent increase in pressure results in air leaving the lungs.

c. The alveoli provide a very large surface area, richly supplied with blood capillaries, so that gases can readily diffuse into and out of the blood.

d. A healthy person constantly breathes automatically. However, spontaneous breathing may stop due to disease or injury. If this happens the patient can be helped to breathe by using a mechanical ventilator. There are two main types of mechanical ventilator: B

- negative pressure ventilators, which cause air to be ‘drawn’ into the lungs
- positive pressure ventilators, which force air into the lungs.

3.2.6 Respiration

a. Respiration in cells can take place aerobically (using oxygen) or anaerobically (without oxygen), to transfer energy.

b During aerobic respiration chemical reactions occur that use glucose (a sugar) and oxygen and transfer energy.

c. Aerobic respiration is represented by the equations:

glucose + oxygen → carbon dioxide + water

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

d. Aerobic respiration takes place continuously in both plants and animals.

e. Most of the reactions in aerobic respiration take place inside mitochondria.

f. The energy that is transferred during respiration may be used by the organism in a variety of ways:

- to build larger molecules from smaller ones
- in animals, to enable muscles to contract
- in mammals and birds, to maintain a steady body temperature in colder surroundings
- in plants, to build up sugars, nitrates and other nutrients into amino acids, which are then built up into proteins.

g. During exercise the human body needs to react to the increased demand for energy. A number of changes take place:

- the heart rate increases, increasing blood flow to the muscles
- the rate and depth of breathing increases
- glycogen stored in the muscles is converted back to glucose.

h. These changes increase the supply of glucose and oxygen to, and increase the rate of removal of carbon dioxide from, the muscles.

i. If insufficient oxygen is reaching the muscles, energy is transferred by anaerobic respiration.

glucose → lactic acid

$C_6H_{12}O_6 \rightarrow 2C_3H_6O_3$

j. Anaerobic respiration in muscles is the incomplete breakdown of glucose, which causes a build-up of lactic acid. An oxygen debt needs to be repaid to oxidise the lactic acid to carbon dioxide and water.

k. As the breakdown of glucose is incomplete, much less energy is transferred in anaerobic respiration than during aerobic respiration.

l. During long periods of vigorous activity muscles become fatigued and stop contracting efficiently. One cause of muscle fatigue is the build-up of lactic acid in the muscles. Blood flowing through the muscles eventually removes the lactic acid.

Required practical:
Investigate the effects of exercise on the human body.

m. Anaerobic respiration in plant cells and in some microorganisms results in the production of ethanol and carbon dioxide.

3.3 Ecology

Materials including carbon and water are continually recycled by the living world, being released through respiration of animals, plants and decomposing microorganisms and taken up by plants in photosynthesis. All species live in ecosystems composed of complex communities of animals and plants dependent on each other and that are adapted to particular conditions, both abiotic and biotic.

3.3.1 Energy transferred in ecosystems

a. Radiation from the Sun is the source of energy for most communities of living organisms. Plants and algae transfer about 1 % of the incident energy from light for photosynthesis. This energy is stored in the substances that make up the cells of the plants.

b. Only approximately 10 % of the biomass from each trophic level is transferred to the level above it because:

- some materials and energy are always lost in the organisms' waste materials
- respiration supplies all the energy needs for living processes, including movement. Much of this energy is eventually transferred to the surroundings.

Construction of food webs and chains, and of pyramids of numbers, is not required. An understanding of pyramids of numbers is not required.

c. The biomass at each stage can be drawn to scale and shown as a pyramid of biomass.

Students should be able to interpret pyramids of biomass and construct them from appropriate information.

d. The efficiency of food production can be improved by reducing the number of stages in a food chain. B

3.3.2 Adaptations, interdependence and competition

a. To survive and reproduce, organisms require a supply of materials from their surroundings and from the other living organisms there.

b. Plants often compete with each other for light and space, and for water and nutrients from the soil.

c. Animals often compete with each other for food, mates and territory.

d. Organisms, including microorganisms, have features (adaptations) that enable them to survive in the conditions in which they normally live.

e. Some organisms live in environments that are very extreme, containing high levels of salt, high temperatures or high pressures. These organisms are called extremophiles.

f. Adaptations include:

- structural adaptations, eg the ways in which organisms are shaped, or coloured
- behavioural adaptations, eg migration, huddling together
- functional adaptations, related to processes such as reproduction and metabolism.

B

Students should be able to explain how some parasites are adapted for living on or inside their hosts. For example:

- *fleas live amongst the hair of mammals*
- *tapeworms live inside the intestines of mammals*

- *malaria parasites are single-celled organisms that cause malaria in humans.*

Students given appropriate information should be able to suggest how animals and plants are adapted to their environment.

3.3.3 Decay and the carbon cycle

a. Living organisms remove materials from the environment for growth and other processes. These materials are returned to the environment either in waste materials or when living things die and decay.

b. Materials decay because they are broken down (digested) by microorganisms. Microorganisms are more active and digest materials faster in warm, moist, aerobic conditions.

c. The decay process releases substances that plants need to grow.

d. In a stable community, the processes that remove materials are balanced by processes that return materials. The materials are part of a constant cycle.

e. The constant cycling of carbon is called the carbon cycle.

   In the carbon cycle:

   - carbon dioxide is removed from the environment by green plants and algae during photosynthesis
   - the carbon from the carbon dioxide is used to make carbohydrates, fats and proteins, which make up the body of plants and algae
   - when green plants and algae respire, some of this carbon becomes carbon dioxide and is released into the atmosphere
   - when green plants and algae are eaten by animals and these animals are eaten by other animals, some of the carbon becomes part of the fats and proteins that make up the bodies of the consumers
   - when animals respire, some of this carbon becomes carbon dioxide and is released into the atmosphere
   - when plants, algae and animals die, some animals and microorganisms feed on their bodies
   - carbon is released into the atmosphere as carbon dioxide when microorganisms respire
   - by the time the microorganisms and detritus feeders have broken down the waste products and dead bodies of organisms in ecosystems and cycled the materials as plant nutrients, all the energy originally absorbed by green plants and algae has been transferred
   - combustion of wood and fossil fuels releases carbon dioxide into the atmosphere.

Students should be able to apply the principles of the carbon cycle.

3.3.4 Humans and their effects on the environment B

a. Rapid growth in the human population and an increase in the standard of living mean that increasingly more waste is produced. Unless waste and chemical materials are properly handled, more pollution will be caused.

b. Waste may pollute:

- water, with sewage, fertiliser or toxic chemicals
- air, with smoke and gases such as sulfur dioxide, which contributes to acid rain
- land, with toxic chemicals such as pesticides and herbicides, which may be washed from land into water
- sewage and fertilisers may cause eutrophication:
  - an increase in the concentration of mineral ions in the water stimulates the growth of algae and/or plants
  - eventually the growth of the algae and/or plants results in some of these being unable to receive sufficient light for photosynthesis and these organisms die
  - there is a large increase in the population of microorganisms that feed on these dead organisms
  - the respiration of the microorganisms depletes the oxygen concentration in the water, leading to the death of aerobic organisms.

c. Large-scale deforestation in tropical areas has led to reduction in biodiversity.

Students should be able to describe the effects of deforestation.

d. Levels of carbon dioxide and methane in the atmosphere are increasing, and contribute to 'global warming'. An increase in the Earth's temperature of only a few degrees Celsius may:

- cause big changes in the Earth's climate
- cause a rise in sea level
- cause changes in migration patterns, eg in birds
- result in changes in the distribution of species.

Throughout this section, students should be able, when provided with appropriate information:

- *to analyse and interpret scientific data concerning environmental issues*
- *to evaluate methods used to collect environmental data and consider their validity and reliability as evidence for environmental change.*

3.4 Organisms' interaction with the environment

Changes in environmental conditions can result in responses from an organism which protect the organism from harm and support maintenance of the species. Such responses may impact the internal stability of the organism or promote certain behaviours to protect it.

3.4.1 The human nervous system

a. The nervous system enables humans to react to their surroundings and to coordinate their behaviour.

b. Information from receptors passes along cells (neurones) as impulses to the central nervous system (CNS). The CNS is the brain and spinal cord. The brain coordinates the response.

c. Reflex actions are automatic and rapid. They often involve sensory, relay and motor neurones.

d. In a simple reflex action such as a pain-withdrawal reflex:

- impulses from a receptor pass along a sensory neurone to the CNS
- at a junction (synapse) between a sensory neurone and a relay neurone in the CNS, a chemical is released that causes an impulse to be sent along a relay neurone
- a chemical is then released at the synapse between a relay neurone and motor neurone in the CNS, causing impulses to be sent along a motor neurone to the effector
- the effector is either a muscle or a gland: a muscle responds by contracting and a gland responds by releasing (secreting) chemical substances.

e. Effectors include muscles and glands.

Students should be able, when provided with appropriate information, to analyse a particular given example of behaviour in terms of:

stimulus → receptor → coordinator → effector → response

3.4.2 Homeostasis

a. Automatic control systems in the body keep conditions inside the body relatively constant.

b. Control systems include:

- cells called receptors, which detect stimuli (changes in the environment)
- coordination centres that receive and process information from receptors
- effectors, which bring about responses.

c. Receptors are found in many organs, including:

- the eyes – sensitive to light
- the ears – sensitive to sound, and to changes in position (which enables us to keep our balance)
- the tongue and in the nose – sensitive to chemicals (enable us to taste and to smell)
- the skin – sensitive to touch, pressure, pain and to temperature changes
- the brain – sensitive to blood temperature and the concentration of water in the blood
- the pancreas – sensitive to the concentration of glucose in the blood.

*Knowledge and understanding of the structure and functions of sense organs such as the eye and the ear is **not** required.*

d. Coordination centres include the brain and spinal cord and the pancreas.

e. Internal conditions that are controlled include:

- temperature
- the water content of the body
- the ion content of the body
- blood glucose levels.

3.4.3 Control of water and ion content of the body B

a. Water leaves the body via the lungs when we breathe out and the skin when we sweat. Excess water is removed via the kidneys in the urine.

b. Urea and ions are lost via the skin when we sweat. Excess ions are removed via the kidneys in the urine.

c. In the liver:

- excess amino acids are deaminated to form ammonia, which is converted into urea for excretion
- poisonous substances are detoxified, and the breakdown products are excreted in the urine via the kidneys
- old blood cells are broken down and the iron is stored.

d. In a healthy kidney:

- the blood is filtered
- all the glucose is reabsorbed
- the dissolved ions needed by the body are reabsorbed
- as much water as the body needs is reabsorbed
- urea, excess ions and excess water are released as urine.

e. If the water content of the blood is too low, the pituitary gland releases a hormone called ADH into the blood. This causes the kidneys to reabsorb more water and results in a more concentrated urine.

f. If the water content of the blood is too high, less ADH is released into the blood. Less water is reabsorbed in the kidneys, resulting in a more dilute urine.

g. The production of ADH is controlled by a negative feedback mechanism.

3.4.4 Temperature control

a. Body temperature is monitored and controlled by the thermoregulatory centre in the brain. The thermoregulatory centre has receptors sensitive to the temperature of the blood flowing through the brain.

*The name of the centre in the brain (hypothalamus) is **not** required.*

b. Temperature receptors in the skin send impulses to the thermoregulatory centre, giving information about skin temperature.

c. If the core body temperature is too high:

- blood vessels supplying the skin capillaries dilate so that more blood flows through the capillaries and more energy is transferred from the skin to the environment
- sweat glands release more sweat, which cools the body as sweat evaporates.

d. Sweating helps to cool the body. More water is lost when it is hot, and more fluid has to be taken through drink or food to balance this loss.

If the core body temperature is too low:

- blood vessels supplying the skin capillaries constrict to reduce the flow of blood through the capillaries
- muscles may 'shiver' – their contraction needs respiration, which transfers some energy to warm the body.

3.4.5 Control of blood glucose

a. The blood glucose concentration is monitored and controlled by the pancreas. Much of the glucose is stored as glycogen in the liver and muscles. When these stores are full, excess glucose is stored as lipid.

b. If blood glucose levels are too high, the pancreas produces the hormone insulin, which allows the glucose to move from the blood into the cells.

c. When blood glucose levels fall, the pancreas produces a second hormone, glucagon. This causes glycogen to be converted into glucose and released into the blood.

d. In Type 1 diabetes a person's blood glucose level may be too high because the pancreas does not produce enough insulin. Type 1 diabetes may be controlled by careful diet, exercise, and by injecting insulin.

e. Type 2 diabetes develops when the body does not respond to its own insulin. Obesity is a significant factor in the development of Type 2 diabetes. Type 2 diabetes can be controlled by careful diet, exercise and by drugs that help the cells to respond to insulin.

3.4.6 Behaviour

Animals exhibit different behaviours.

a. Sexual reproduction requires the finding and selection of a suitable mate, and can involve courtship behaviours that advertise an individual's quality. Animals have different mating strategies, including:

- a mate for life
- several mates over a life time
- a mate for a breeding season
- several mates over one breeding season.

b. Some animals have developed special behaviours for rearing their young. Parental care can be a successful evolutionary strategy, including:

- increased chance of survival of offspring
- increased chance of parental genes being passed on by the offspring.

Students should be able to explain how, within the animal kingdom, parental care may involve risks to the parents.

c. The different behaviours displayed by animals include:

- innate behaviour
- imprinting
- habituation
- classic conditioning
- operant conditioning.

d. Humans can make use of conditioning when training captive animals for specific purposes, including:

- sniffer dogs
- police horses.

e. Methods of communication within the animal kingdom. Animals use a variety of types of signals to communicate.

Students should be able to describe the types of signals animals use to communicate eg sound, chemical, visual.

3.4.7 Infection and response

a. Microorganisms that cause infectious disease are called pathogens.

b. Bacteria and viruses may reproduce rapidly inside the body. Bacteria may produce poisons (toxins) that make us feel ill. Viruses live and reproduce inside cells, causing damage.

*Knowledge of the structure of viruses is **not** required.*

c. White blood cells help to defend against pathogens by:

- ingesting pathogens (phagocytosis)
- producing antibodies, which destroy particular bacteria or viruses
- producing antitoxins, which counteract the toxins released by the pathogens.

d. The immune system of the body produces specific antibodies to kill a particular pathogen. This leads to immunity from that pathogen. In some cases, dead or inactivated pathogens stimulate antibody production. If a large proportion of the population is immune to a pathogen, the spread of the pathogen is very much reduced.

e. People can be immunised against a disease by introducing small quantities of dead or inactive forms of the pathogen into the body (vaccination). Vaccines stimulate the white blood cells to produce antibodies that destroy the pathogen. This makes the person immune to future infections by the microorganism, because the body can respond by rapidly making the correct antibody, in the same way as if the person had previously had the disease. The MMR vaccine is used to protect children against measles, mumps and rubella.

*Details of vaccination schedules and side effects associated with specific vaccines are **not** required.*

Students should be able to evaluate the advantages and disadvantages of being vaccinated against a particular disease.

f. Antibiotics, such as penicillin, are medicines that help to cure bacterial disease by killing infective bacteria inside the body. It is important that specific bacteria should be treated by specific antibiotics. The use of antibiotics has greatly reduced deaths from infectious bacterial diseases.

g. Antibiotics cannot kill viral pathogens.

Students should be aware that it is difficult to develop drugs that kill viruses without also damaging the body's tissues.

h. Mutations of pathogens produce new strains. Antibiotics kill individual pathogens of the non-resistant strain but individual resistant pathogens survive and reproduce, so the population of the resistant strain rises. Antibiotics and vaccinations may no longer be effective against a new resistant strain of the pathogen. The new strain will spread rapidly because people are not immune to it and there is no effective treatment.

Knowledge of development of resistance in bacteria is limited to the fact that pathogens mutate, producing resistant strains.

i. Many strains of bacteria, including MRSA, have developed resistance to antibiotics. Overuse and inappropriate use of antibiotics has increased the rate of development of antibiotic-resistant strains of bacteria. Antibiotics are not currently used to treat non-serious infections such as mild throat infections, in order to slow down the rate of development of resistant strains.

j. The development of antibiotic-resistant strains of bacteria necessitates the development of new antibiotics.

Required practical:
Investigate the effect of disinfectants and antibiotics on uncontaminated cultures of microorganisms.

3.5 Inheritance

Genetic information in a cell is held in the chemical DNA. Genes determine the development and structure of organisms. In asexual reproduction all the genes in the offspring come from one parent. In sexual reproduction half of the genes come from each parent.

3.5.1 Reproduction

a. There are two forms of reproduction:

- sexual reproduction – the joining (fusion) of male and female gametes. The mixture of the genetic information from two parents leads to variety in the offspring
- asexual reproduction – no fusion of gametes and only one individual is needed as the parent. There is no mixing of genetic information and so no genetic variation in the offspring. These genetically identical individuals are known as clones.

3.5.2 Cell division

a. The nucleus of a cell contains chromosomes. Chromosomes carry genes that control the characteristics of the body. Each chromosome carries a large number of genes.

b. Many genes have different forms called alleles, which may produce different characteristics.

c. In body cells the chromosomes are normally found in pairs.

d. Body cells divide by mitosis to produce additional cells during growth or to produce replacement cells.

e. When a body cell divides by mitosis:

- copies of the genetic material are made
- the cell then divides once to form two genetically identical body cells.

f. Cells in reproductive organs divide to form gametes.

g. A cell divides to form gametes by meiosis.

h. When a cell divides to form gametes:

- copies of the genetic information are made
- the cell then divides twice to form four gametes, each with a single set of chromosomes.

i. Gametes join at fertilisation to form a single body cell with new pairs of chromosomes. This cell repeatedly divides by mitosis to form many cells. As an organism develops, these cells differentiate to form different kinds of cells.

j. Most types of animal cell differentiate at an early stage, whereas many plant cells retain the ability to differentiate throughout life. In mature animals, cell division is mainly restricted to repair and replacement.

k. Cells from human embryos and adult bone marrow, called stem cells, can be made to differentiate into many different types of human cell.

l. In therapeutic cloning an embryo is produced with the same genes as the patient. Stem cells from the embryo will not be rejected by the patient's body so they may be used for medical treatment.

m. Treatment with stem cells may be able to help conditions such as paralysis.

*Knowledge and understanding of stem cell techniques is **not** required.*

Students should be able, when provided with appropriate information, to make informed judgements about the social and ethical issues concerning the use of stem cells from adult bone marrow and embryos in medical research and treatments.

n. Tumours result from the abnormal, uncontrolled growth of cells. B

   Benign tumours do not invade other tissues. B

   Cells from malignant tumours invade healthy tissue. Some malignant cells may enter the bloodstream and circulate to other parts of the body, forming secondary tumours. B

o. Tumours can be caused by chemical carcinogens, eg those found in tobacco smoke and in asbestos, and by ionising radiation, eg UV and X-rays. B

3.5.3 Genetic variation

a. Differences in the characteristics of individuals of the same kind may be due to differences in:

   - the genes they have inherited (genetic causes)
   - the conditions in which they have developed (environmental causes)
   - a combination of genetic and environmental causes.

b. The information that results in plants and animals having similar characteristics to their parents is carried by genes, which are passed on in the sex cells (gametes) from which the offspring develop.

c. The nucleus of a cell contains chromosomes. Chromosomes carry genes that control the characteristics of the body. Chromosomes are normally found in pairs.

d. In human body cells, one of the 23 pairs of chromosomes carries the genes that determine sex. In females the sex chromosomes are the same (XX); in males the sex chromosomes are different (XY).

e. Different genes control the development of different characteristics of an organism. Some characteristics are controlled by a single gene. Each gene may have different forms called alleles.

Students should understand that genes operate at a molecular level to develop characteristics that can be seen.

f. If both chromosomes in a pair contain the same allele of a gene, the individual is homozygous for that gene. If the chromosomes in a pair contain different alleles of a gene, the individual is heterozygous for that gene.

g. An allele that controls the development of a characteristic when it is present on only one of the chromosomes is called a dominant allele. An allele that controls the development of a characteristic only if the dominant allele is not present is called a recessive allele.

Students should be familiar with principles used by Mendel in investigating monohybrid inheritance in peas. They should understand that Mendel's work preceded the work by other scientists which linked Mendel's 'inherited factors' with chromosomes.

Students should be able to construct genetic diagrams of monohybrid crosses and to predict the outcomes of monohybrid crosses. They should be able to use the terms homozygous, heterozygous, phenotype and genotype.

Students should understand that genetic diagrams are biological models which can be used to predict the outcomes of crosses.

Students should be able to interpret genetic diagrams, including family trees.

h. Chromosomes are made up of large molecules of DNA. DNA contains the coded information that determines inherited characteristics.

i. A gene is a small section of DNA. Each gene codes for a particular combination of amino acids, to make a

specific protein.

j. DNA is made of very long strands, twisted to form a double helix, which contain four different compounds, called bases.

*Students are **not** expected to know the names of the four bases or how complementary pairs of bases enable DNA replication to take place.*

k. A sequence of three bases is the code for a particular amino acid. The order of bases controls the order in which amino acids are assembled to produce a particular protein.

3.5.4 Genetic disorders

Attention is drawn to the potential sensitivity needed in teaching about inherited disorders.

a. Some disorders are inherited.

Students should be able to interpret data relating to genetic disorders such as polydactyly, cystic fibrosis, and sickle cell anaemia.

b. Some inherited conditions are caused by inheritance of abnormal numbers of chromosomes, eg Down's Syndrome is caused by the presence of an extra chromosome.

3.5.5 Genetic manipulation

a. Modern cloning techniques include:

- tissue culture – using small groups of cells from part of a plant
- 'cuttings' – an older, but simple, method used by gardeners to produce many identical new plants from a parent plant B
- embryo transplants – splitting apart cells from a developing animal embryo before they become specialised, then transplanting the identical embryos into host mothers
- adult cell cloning – the nucleus is removed from an unfertilised egg cell and the nucleus from an adult body cell, eg a skin cell, is inserted into the egg cell. An electric shock then acts as the catalyst for the egg cell to begin to divide to form embryo cells. These embryo cells contain the same genetic information as the adult skin cell. When the embryo has developed into a ball of cells, it is inserted into the womb of an adult female to continue its development.

b. In genetic engineering, genes from the chromosomes of humans and other organisms can be 'cut out' and transferred to cells of other organisms:

- enzymes are used to isolate the required gene
- this gene is inserted into a vector, usually a bacterial plasmid or a virus
- the vector is used to insert the gene into the required cells.

c. Genes can also be transferred to the cells of animals, plants or microorganisms at an early stage in their development so that they develop with desired characteristics.

d. Crops that have had their genes modified in this way are called genetically modified (GM) crops. GM crops include ones that are resistant to insect attack or to herbicides.

e. GM crops generally show increased yields.

f. Concerns about GM crops include the effect on populations of wild flowers and insects, and uncertainty about

the effects of eating GM crops on human health.

Students should be able, when provided with appropriate information, to interpret information about cloning techniques and genetic engineering techniques and to make informed judgements about issues concerning cloning and genetic engineering, including GM crops.

3.6 Variation and evolution

All life today is directly descended from a universal common ancestor that was a simple single-celled organism. Over countless generations changes resulted from natural diversity within a species which makes possible the selection of those individuals best suited to survive under certain conditions. Species not able to respond sufficiently to changes in their environment are at risk of becoming extinct.

3.6.1 Continuous and discontinuous variation

The causes of variation include:

- genetic variation – different characteristics as a result of mutation or reproduction
- environmental variation – different characteristics caused by an organism's environment (acquired characteristics).

3.6.2 Natural selection

a. Theories of how organisms have evolved include:

- the theory of evolution by natural selection
- other theories, including that of Lamarck, are based mainly on the idea that changes that occur in an organism during its lifetime can be inherited. We now know that in the vast majority of cases this type of inheritance cannot occur.

b. Evolution occurs via natural selection.

- Individual organisms within a particular species may show a wide range of variation because of differences in their genes.
- Individuals with characteristics most suited to the environment are more likely to survive to breed successfully.
- The genes that have enabled these individuals to survive are then passed on to the next generation.

Students should develop an understanding of the time scales involved in evolution.

c. New species arise as a result of:

- isolation: two populations of a species become separated, eg geographically
- genetic variation: each population has a wide range of alleles that control their characteristics
- natural selection: in each population, the alleles that control the characteristics which help the organism to survive are selected
- speciation: the populations become so different that successful interbreeding leading to fertile offspring is no longer possible.

4 Scheme of assessment

Find mark schemes, and specimen papers for new courses, on our website at **oxfordaqa.com/9201**

This specification is designed to be taken over two years.

This is a linear qualification. In order to achieve the award, students must complete all assessments at the end of the course and in the same series.

Our International GCSE exams and certification for this specification are available for the first time in May/June 2018 and then every May/June and November for the life of the specification.

All materials are available in English only.

Our International GCSE exams in Biology include questions that allow students to demonstrate their ability to:

- recall the knowledge and understanding developed through the substantive content of the course
- apply their knowledge and understanding gained in discussing, evaluating and suggesting implications of data and evidence in both familiar and unfamiliar situations
- understand the scientific process while working scientifically and the skills developed while carrying out practical investigations.

4.1 Aims and learning outcomes

Our International GCSE in Biology should encourage students to be inspired, motivated and challenged by following a broad, coherent, practical, satisfying and worthwhile course of study. It should encourage students to develop their curiosity about the living world, enable students to engage with biology in their everyday lives in order to make informed choices about further study in biology and related disciplines.

Our International GCSE in Biology should enable students to:

- develop their knowledge and understanding of biology develop and apply their knowledge and understanding of the scientific process
- develop their understanding of the relationships between hypotheses, evidence, theories and explanations
- develop and apply their observational, practical, modelling, enquiry and problem-solving skills, and their understanding in laboratory, field and 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
- develop their skills in reporting and presenting information clearly and logically in different formats
- develop their skills in communication, mathematics and the use of technology in scientific contexts.

4.2 Assessment Objectives

The exams will measure how students have achieved the following assessment objectives.

- AO1: Knowledge and understanding of scientific principles.
- AO2: Application of knowledge and understanding of scientific principles and concepts in both familiar and novel contexts.
- AO3: Ability to describe, analyse, interpret and evaluate scientific information presented in different forms.
- AO4: Ability to select, describe and evaluate scientific procedures.

4.2.1 Assessment Objective weightings

Assessment Objectives (AOs)	Component weightings (approx %)		Overall weighting (approx %)
	Paper 1	Paper 2	
AO1	20	10	30
AO2	20	20	40
AO3	7	13	20
AO4	3	7	10
Overall weighting of components (%)	50	50	100

4.3 Assessment weightings

The assessments are equally weighted.

Component	Maximum mark
Paper 1	90
Paper 2	90
Total mark:	180

5 General administration

We are committed to delivering assessments of the highest quality and have developed practices and procedures that support this aim. To ensure that all students have a fair experience, we have worked with other awarding bodies in England to develop best practice for maintaining the integrity of exams. This is published through the Joint Council for Qualifications (JCQ). We will maintain the same high standard through their use for OxfordAQA.

More information on all aspects of administration is available at **oxfordaqa.com/exams-administration**

For any immediate enquiries please contact **info@oxfordaqa.com**

Please note: We aim to respond to all email enquiries within two working days.

Our UK office hours are Monday to Friday, 8am – 5pm local time.

5.1 Entries and codes

You only need to make one entry for each qualification – this will cover all the question papers and certification.

Qualification title	OxfordAQA entry code
OxfordAQA International GCSE Biology	9201

Please check the current version of the Entry Codes book and the latest information about making entries on **oxfordaqa.com/exams-administration**

Exams will be available May/June and in November.

5.2 Overlaps with other qualifications

This specification overlaps with the AQA UK GCSE Biology (8461). This specification overlaps with the OxfordAQA International GCSE Combined Science (9204). Entry for this specification and OxfordAQA International GCSE Combined Science (9204) is **not** permitted in the same series.

5.3 Awarding grades and reporting results

In line with UK GCSEs, this qualification will be graded on a nine-point scale: 1 to 9 – where 9 is the best grade. Students who fail to reach the minimum standard for grade 1 will be recorded as U (unclassified) and will not receive a qualification certificate.

To find out more about the new grading system, visit our website at **oxfordaqa.com**

5.4 Resits

Candidates can re-take the whole qualification as many times as they wish. This is a traditional linear specification, individual components cannot be re-sat.

You only need to make one entry for each qualification – this will cover all the question papers and certification.

5.5 Previous learning and prerequisites

There are no previous learning requirements. Any requirements for entry to a course based on this specification are at the discretion of schools.

5.6 Access to assessment: equality and inclusion

Our general qualifications are designed to prepare students for a wide range of occupations and further study whilst assessing a wide range of competences.

The subject criteria have been assessed to ensure they test specific competences. The skills or knowledge required do not disadvantage particular groups of students.

Exam access arrangements are available for students with disabilities and special educational needs.

We comply with the *UK Equality Act 2010* to make reasonable adjustments to remove or lessen any disadvantage that affects a disabled student. Information about access arrangements will be issued to schools when they become OxfordAQA centres.

5.7 Working with OxfordAQA for the first time

You will need to apply to become an OxfordAQA centre to offer our specifications to your students. Find out how at **oxfordaqa.com/centreapprovals**

5.8 Private candidates

Centres may accept private candidates for examined units/components only with the prior agreement of OxfordAQA. If you are an approved OxfordAQA centre and wish to accept private candidates, please contact OxfordAQA at: **info@oxfordaqa.com**

As some of the marks in the GCSE papers will relate to practical work, students undertaking this specification must carry out the required practical activities in section 6.2 of the specification.

Centres accepting private candidates must ensure they have carried out this minimum requirement. Private candidates may also enter for examined only units via the British Council; please contact your local British Council office for details.

6 Appendices

6.1 Experimental and investigative skills

During this course, students should be encouraged to develop their understanding of the scientific process and the skills associated with scientific enquiry. In Paper 2, students will be assessed on aspects of the skills listed below, and may be required to read and interpret information from scales given in diagrams and charts, present data in appropriate formats, design investigations and evaluate information that is presented to them.

Scientific process and skill	
Designing a practical procedure	Design a practical procedure to answer a question, solve a problem or test a hypothesis.
	Comment on/evaluate plans for practical procedures.
	Select suitable apparatus for carrying out experiments accurately and safely.
Control	Appreciate that, unless certain variables are controlled, experimental results may not be valid.
	Recognise the need to choose appropriate sample sizes, and study control groups where necessary.
Risk assessment	Identify possible hazards in practical situations, the risks associated with these hazards, and methods of minimising the risks.
Collecting data	Make and record observations and measurements with appropriate precision and record data collected in an appropriate format (such as a table, chart or graph).
Analysing data	Recognise and identify the cause of anomalous results and suggest what should be done about them.
	Appreciate when it is appropriate to calculate a mean, calculate a mean from a set of at least three results and recognise when it is appropriate to ignore anomalous results in calculating a mean.
	Recognise and identify the causes of random errors and systematic errors.
	Recognise patterns in data, form hypotheses and deduce relationships.
	Use and interpret tabular and graphical representations of data.
Making conclusions	Draw conclusions that are consistent with the evidence obtained and support them with scientific explanations.
Evaluation	Evaluate data, considering its repeatability, reproducibility and validity in presenting and justifying conclusions.
	Evaluate methods of data collection and appreciate that the evidence obtained may not allow a conclusion to be made with confidence.
	Suggest ways of improving an investigation or practical procedure to obtain extra evidence to allow a conclusion to be made.

6.2 Required practicals

The table below summarises the five required practicals.

Specification	Suggested required practicals
1. Organisation 3.1.5 Transport in cells B	Investigate the effect of different concentrations of solutions separated by a semi permeable membrane.
2. Bioenergetics 3.2.1 Photosynthesis	Investigate how variables affect the rate of photosynthesis.
3. Bioenergetics 3.2.4 Digestion B	Investigate how different temperatures, and pH affect the rate of digestion.
4. Bioenergetics 3.2.6 Respiration	Investigate the effects of exercise on the human body.
5. Organisms' interaction with the environment 3.4.7 Infection and response	Investigate the effect of disinfectants and antibiotics on uncontaminated cultures of microorganisms.

Opportunities to develop experimental and investigative skills during the teaching and learning of the required practicals are indicated in the table below.

Scientific process and skill	Osmosis	Rate of photosynthesis	Enzymes	Exercise	Microbes
Designing a practical procedure	x	✓	x	✓	x
Control	x	✓	✓	x	✓
Risk assessment	✓	✓	✓	✓	✓
Collecting data	✓	✓	✓	✓	✓
Analysing data	✓	✓	✓	✓	✓
Making conclusions	✓	✓	✓	✓	✓
Evaluation	✓	✓	✓	✓	✓

6.3 Mathematical requirements

This specification provides learners with the opportunity to develop their skills in communication, mathematics and the use of technology in scientific contexts. In order to deliver the mathematical element of this outcome, assessment materials for this specification contain opportunities for students to demonstrate scientific knowledge using appropriate mathematical skills.

The areas of mathematics that arise naturally from the science content are listed below. This is not a checklist for each question paper, but assessments reflect these mathematical requirements, covering the full range of mathematical skills over a reasonable period of time.

Students are permitted to use calculators in all assessments.

Students are expected to use units appropriately. However, not all questions reward the appropriate use of units.

All students should be able to:

1. Understand number size and scale and the quantitative relationship between units.

2. Understand when and how to use estimation.

3. Carry out calculations involving +, –, x, ÷, either singly or in combination, decimals, fractions, percentages and positive whole number powers.

4. Provide answers to calculations to an appropriate number of significant figures.

5. Understand and use the symbols =, <, >, ~

6. Understand and use direct proportion and simple ratios.

7. Calculate arithmetic means.

8. Understand and use common measures and simple compound measures such as speed.

9. Plot and draw graphs (line graphs, bar charts, pie charts, scatter graphs, histograms) selecting appropriate scales for the axes.

10. Substitute numerical values into simple formulae and equations using appropriate units.

11. Translate information between graphical and numeric form.

12. Extract and interpret information from charts, graphs and tables.

13. Understand the idea of probability.

14. Calculate area, perimeters and volumes of simple shapes.

15. Interpret order and calculate with numbers written in standard form.

16. Carry out calculations involving negative powers (only –1 for rate).

17. Change the subject of an equation.

18. Understand and use inverse proportion.

19. Understand and use percentiles and deciles.

Units, symbols and nomenclature

Units, symbols and nomenclature used in examination papers will normally conform to the recommendations contained in the following:

- *The Language of Measurement: Terminology used in school science investigations*. Association for Science Education (ASE), 2010. ISBN 978 0 86357 424 5.
- *Signs, Symbols and Systematics – the ASE companion to 16–19 Science*. Association for Science Education (ASE), 2000. ISBN 978 0 86357 312 5.
- *Signs, Symbols and Systematics – the ASE companion to 5–16 Science*. Association for Science Education (ASE), 1995. ISBN 0 86357 232 4.

6.4 Glossary of subject specific terminology

The following subject specific vocabulary provides definitions of key terms used in our International GCSE science specifications.

Wherever possible we have used the definitions derived from a booklet created in a joint project of the Association for Science Education and the Nuffield Foundation:

The Language of Measurement: Terminology used in school science investigations. Association for Science Education (ASE), 2010. ISBN 978 0 86357 424 5.

This list is **draft** and subject to change.

Accuracy

A measurement result is considered accurate if it is judged to be close to the true value.

Calibration

Marking a scale on a measuring instrument.

This involves establishing the relationship between indications of a measuring instrument and standard or reference quantity values, which must be applied.

For example, placing a thermometer in melting ice to see whether it reads zero, in order to check if it has been calibrated correctly.

Data

Information, either qualitative or quantitative, that has been collected.

Errors

See also uncertainty.

Measurement error: the difference between a measured value and the true value.

Anomalies: these are values in a set of results which are judged not to be part of the variation caused by random uncertainty.

Random error: these cause readings to be spread about the true value, due to results varying in an unpredictable way from one measurement to the next. Random errors are present when any measurement is made, and cannot be corrected. The effect of random errors can be reduced by making more measurements and calculating a new mean.

Systematic error: these cause readings to differ from the true value by a consistent amount each time a measurement is made. Sources of systematic error can include the environment, methods of observation or instruments used. Systematic errors cannot be dealt with by simple repeats. If a systematic error is suspected, the data collection should be repeated using a different technique or a different set of equipment, and the results compared.

Zero error: any indication that a measuring system gives a false reading when the true value of a measured quantity is zero, eg the needle on an ammeter failing to return to zero when no current flows. A zero error may result in a systematic uncertainty.

Evidence

Data which has been shown to be valid.

Fair test

A fair test is one in which only the independent variable has been allowed to affect the dependent variable.

Hypothesis

A proposal intended to explain certain facts or observations.

Interval

The quantity between readings, eg a set of 11 readings equally spaced over a distance of 1 metre would give an interval of 10 centimetres.

Precision

Precise measurements are ones in which there is very little spread about the mean value.

Precision depends only on the extent of random errors – it gives no indication of how close results are to the true value.

Prediction

A prediction is a statement suggesting what will happen in the future, based on observation, experience or a hypothesis.

Range

The maximum and minimum values of the independent or dependent variables; important in ensuring that any pattern is detected.

For example a range of distances may be quoted as either: 'From 10 cm to 50 cm' or 'From 50 cm to 10 cm'.

Repeatable

A measurement is repeatable if the original experimenter repeats the investigation using same method and equipment and obtains the same results.

Reproducible

A measurement is reproducible if the investigation is repeated by another person, or by using different equipment or techniques, and the same results are obtained.

Resolution

This is the smallest change in the quantity being measured (input) of a measuring instrument that gives a perceptible change in the reading.

Sketch graph

A line graph, not necessarily on a grid, that shows the general shape of the relationship between two variables. It will not have any points plotted and although the axes should be labelled they may not be scaled.

True value

This is the value that would be obtained in an ideal measurement.

Uncertainty

The interval within which the true value can be expected to lie, with a given level of confidence or probability, eg 'the temperature is 20 °C ± 2 °C, at a level of confidence of 95 %'.

Validity

Suitability of the investigative procedure to answer the question being asked. For example, an investigation to find out if the rate of a chemical reaction depended upon the concentration of one of the reactants would not be a valid procedure if the temperature of the reactants was not controlled.

Valid conclusion

A conclusion supported by valid data, obtained from an appropriate experimental design and based on sound reasoning.

Variables

These are physical, chemical or biological quantities or characteristics.

Categoric: categoric variables have values that are labels eg names of plants or types of material.

Continuous: continuous variables can have values (called a quantity) that can be given a magnitude either by counting (as in the case of the number of shrimp) or by measurement (eg light intensity, flow rate etc).

Control: a control variable is one which may, in addition to the independent variable, affect the outcome of the investigation and therefore has to be kept constant or at least monitored.

Dependent: the dependent variable is the variable of which the value is measured for each and every change in the independent variable.

Independent: the independent variable is the variable for which values are changed or selected by the investigator.

Terms no longer used

The term 'discrete variable' will no longer be used as this has been subsumed by the definition of 'continuous variable'.

The terms 'reliable' and 'reliability' will no longer be used. Instead, the terms 'repeatable' or 'repeatability' and 'reproducible' or 'reproducibility' will be used.

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