Cambridge Assessment International Education

Syllabus

Cambridge IGCSE™

Biology 0610

Use this syllabus for exams in 2026, 2027 and 2028.
Exams are available in the June and November series.
Exams are also available in the March series in India.

Version 1

For the purposes of screen readers, any mention in this document of Cambridge IGCSE refers to Cambridge International General Certificate of Secondary Education.

Cambridge Pathway

Why choose Cambridge International?

Cambridge International prepares school students for life, helping them develop an informed curiosity and a lasting passion for learning. We are part of the University of Cambridge.

Our Cambridge Pathway gives students a clear path for educational success from age 5 to 19. Schools can shape the curriculum around how they want students to learn – with a wide range of subjects and flexible ways to offer them. It helps students discover new abilities and a wider world, and gives them the skills they need for life, so they can achieve at school, university and work.

Our programmes and qualifications set the global standard for international education. They are created by subject experts, are rooted in academic rigour and reflect the latest educational research. They provide a strong platform for learners to progress from one stage to the next, and are well supported by teaching and learning resources. Learn more about our research at **www.cambridgeassessment.org.uk/our-research/**

We believe education works best when curriculum, teaching, learning and assessment are closely aligned. Our programmes develop deep knowledge, conceptual understanding and higher-order thinking skills, to prepare students for their future. Together with schools, we develop Cambridge learners who are confident, responsible, reflective, innovative and engaged – equipped for success in the modern world.

Every year, nearly a million Cambridge students from 10 000 schools in 160 countries prepare for their future with the Cambridge Pathway.

School feedback: 'We think the Cambridge curriculum is superb preparation for university.'

Feedback from: Christoph Guttentag, Dean of Undergraduate Admissions, Duke University, USA

Quality management

Cambridge International is committed to providing exceptional quality. In line with this commitment, our quality management system for the provision of international education programmes and qualifications for students aged 5 to 19 is independently certified as meeting the internationally recognised standard, ISO 9001:2015. Learn more at **www.cambridgeinternational.org/about-us/our-standards/**

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Important: Changes to this syllabus

The latest syllabus is version 1, published September 2023. There are no significant changes which affect teaching.

Any textbooks endorsed to support the syllabus for examination from 2023 are still suitable for use with this syllabus.

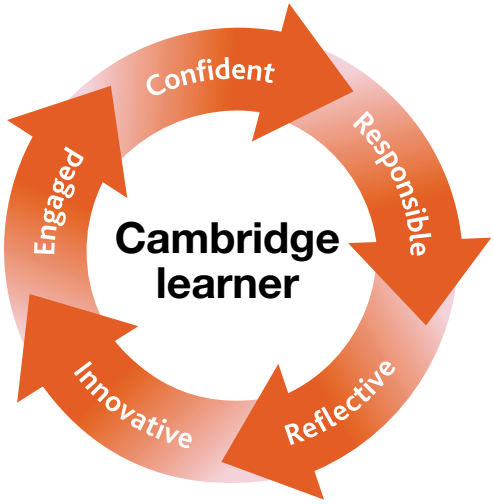
1 Why choose this syllabus?

Key benefits

Cambridge IGCSE is the world's most popular international qualification for 14 to 16 year olds, although it can be taken by students of other ages. It is tried, tested and trusted.

Students can choose from 70 subjects in any combination – it is taught by over 5000 schools in 150 countries.

Our programmes promote a thorough knowledge and understanding of a subject and help to develop the skills learners need for their next steps in education or employment.



Cambridge IGCSE Biology develops a set of transferable skills including handling data, practical problem-solving and applying the scientific method. Learners develop relevant attitudes, such as concern for accuracy and precision, objectivity, integrity, enquiry, initiative and inventiveness. They acquire the essential scientific skills required for progression to further studies or employment.

Our approach in Cambridge IGCSE Biology encourages learners to be:

confident, interested in learning about science, questioning ideas and using scientific language to communicate their views and opinions

responsible, working methodically and safely when working alone or collaboratively with others

reflective, learning from their experiences and interested in scientific issues that affect the individual, the community and the environment

innovative, solving unfamiliar problems confidently and creatively

engaged, keen to develop scientific skills, being curious about scientific principles and their application in the world.

School feedback: 'The strength of Cambridge IGCSE qualifications is internationally recognised and has provided an international pathway for our students to continue their studies around the world.'

Feedback from: Gary Tan, Head of Schools and CEO, Raffles Group of Schools, Indonesia

International recognition and acceptance

Our expertise in curriculum, teaching and learning, and assessment is the basis for the recognition of our programmes and qualifications around the world. The combination of knowledge and skills in Cambridge IGCSE Biology gives learners a solid foundation for further study. Candidates who achieve grades A* to C are well prepared to follow a wide range of courses including Cambridge International AS & A Level Biology or Marine Science.

Cambridge IGCSEs are accepted and valued by leading universities and employers around the world as evidence of academic achievement. Cambridge students can be confident that their qualifications will be understood and valued throughout their education and career, in their home country and internationally. Many universities require a combination of Cambridge International AS & A Levels and Cambridge IGCSEs or equivalent to meet their entry requirements.

UK ENIC, the national agency in the UK for the recognition and comparison of international qualifications and skills, has carried out an independent benchmarking study of Cambridge IGCSE and found it to be comparable to the standard of the GCSE in the UK. This means students can be confident that their Cambridge IGCSE qualifications are accepted as equivalent to UK GCSEs by leading universities worldwide.

Learn more at **www.cambridgeinternational.org/recognition**

School feedback: 'Cambridge IGCSE is one of the most sought-after and recognised qualifications in the world. It is very popular in Egypt because it provides the perfect preparation for success at advanced level programmes.'

Feedback from: Managing Director of British School of Egypt BSE

Supporting teachers

We believe education is most effective when curriculum, teaching and learning, and assessment are closely aligned. We provide a wide range of resources, detailed guidance, innovative training and targeted professional development so that you can give your students the best possible preparation for Cambridge IGCSE. To find out which resources are available for each syllabus go to our School Support Hub.

The School Support Hub is our secure online site for Cambridge teachers where you can find the resources you need to deliver our programmes. You can also keep up to date with your subject and the global Cambridge community through our online discussion forums.

Find out more at **www.cambridgeinternational.org/support**

Support for Cambridge IGCSE			
Planning and preparation • Syllabuses • Schemes of work • Specimen Question Papers and Mark Schemes • Teacher guides	**Teaching and assessment** • Endorsed resources • Online forums • Resource Plus • Everyday Science	**Learning and revision** • Example candidate responses • Past papers and mark schemes • Specimen paper answers • Test Maker	**Results** • Candidate Results Service • Principal examiner reports for teachers • Results Analysis

Sign up for email notifications about changes to syllabuses, including new and revised products and services, at **www.cambridgeinternational.org/syllabusupdates**

Syllabuses and specimen materials represent the final authority on the content and structure of all of our assessments.

Professional development

Find the next step on your professional development journey.

- Introductory Professional Development – An introduction to Cambridge programmes and qualifications.
- Extension Professional Development – Develop your understanding of Cambridge programmes and qualifications to build confidence in your delivery.
- Enrichment Professional Development – Transform your approach to teaching with our Enrichment workshops.
- Cambridge Professional Development Qualifications (PDQs) – Practice-based programmes that transform professional learning for practising teachers. Available at Certificate and Diploma level.

Find out more at:
www.cambridgeinternational.org/support-and-training-for-schools/professional-development/

Supporting exams officers

We provide comprehensive support and guidance for all Cambridge exams officers.
Find out more at: **www.cambridgeinternational.org/eoguide**

2 Syllabus overview

Aims

The aims describe the purposes of a course based on this syllabus.

You can deliver some of the aims using suitable local, international or historical examples and applications, or through collaborative experimental work.

The aims are to enable students to:

- acquire scientific knowledge and understanding of scientific theories and practice
- develop a range of experimental skills, including handling variables and working safely
- use scientific data and evidence to solve problems and discuss the limitations of scientific methods
- communicate effectively and clearly, using scientific terminology, notation and conventions
- understand that the application of scientific knowledge can benefit people and the environment
- enjoy science and develop an informed interest in scientific matters which support further study.

Cambridge Assessment International Education is an education organisation and politically neutral. The contents of this syllabus, examination papers and associated materials do not endorse any political view. We endeavour to treat all aspects of the exam process neutrally.

Content overview

Candidates study the following topics:

1 Characteristics and classification of living organisms
2 Organisation of the organism
3 Movement into and out of cells
4 Biological molecules
5 Enzymes
6 Plant nutrition
7 Human nutrition
8 Transport in plants
9 Transport in animals
10 Diseases and immunity
11 Gas exchange in humans
12 Respiration
13 Excretion in humans
14 Coordination and response
15 Drugs
16 Reproduction
17 Inheritance
18 Variation and selection
19 Organisms and their environment
20 Human influences on ecosystems
21 Biotechnology and genetic modification

Assessment overview

All candidates take three components. Candidates will be eligible for grades A* to G.

Candidates who have studied the Core syllabus content, or who are expected to achieve a grade D or below, should be entered for Paper 1, Paper 3 and either Paper 5 or Paper 6. These candidates will be eligible for grades C to G.

Candidates who have studied the Extended syllabus content (Core and Supplement), and who are expected to achieve a grade C or above, should be entered for Paper 2, Paper 4 and either Paper 5 or Paper 6. These candidates will be eligible for grades A* to G.

Core assessment

Core candidates take Paper 1 and Paper 3. The questions are based on the Core subject content only:

Paper 1: Multiple Choice (Core)	
45 minutes	
40 marks	30%
40 four-option multiple-choice questions	
Externally assessed	

Paper 3: Theory (Core)	
1 hour 15 minutes	
80 marks	50%
Short-answer and structured questions	
Externally assessed	

Extended assessment

Extended candidates take Paper 2 and Paper 4. The questions are based on the Core and Supplement subject content:

Paper 2: Multiple Choice (Extended)	
45 minutes	
40 marks	30%
40 four-option multiple-choice questions	
Externally assessed	

Paper 4: Theory (Extended)	
1 hour 15 minutes	
80 marks	50%
Short-answer and structured questions	
Externally assessed	

Practical assessment

All candidates take one practical paper from a choice of two:

Paper 5: Practical Test	
1 hour 15 minutes	
40 marks	20%
Questions will be based on the experimental skills in Section 4	
Externally assessed	

OR

Paper 6: Alternative to Practical	
1 hour	
40 marks	20%
Questions will be based on the experimental skills in Section 4	
Externally assessed	

Information on availability is in the **Before you start** section.

Assessment objectives

The assessment objectives (AOs) are:

AO1 Knowledge with understanding

Candidates should be able to demonstrate knowledge and understanding of:

- scientific phenomena, facts, laws, definitions, concepts and theories
- scientific vocabulary, terminology and conventions (including symbols, quantities and units)
- scientific instruments and apparatus, including techniques of operation and aspects of safety
- scientific and technological applications with their social, economic and environmental implications.

Subject content defines the factual material that candidates may be required to recall and explain.

Candidates will also be asked questions which require them to apply this material to unfamiliar contexts and to apply knowledge from one area of the syllabus to another.

AO2 Handling information and problem-solving

Candidates should be able, in words or using other written forms of presentation (i.e. symbolic, graphical and numerical), to:

- locate, select, organise and present information from a variety of sources
- translate information from one form to another
- manipulate numerical and other data
- use information to identify patterns, report trends and form conclusions
- present reasoned explanations for phenomena, patterns and relationships
- make predictions based on relationships and patterns
- solve problems, including some of a quantitative nature.

Questions testing these skills may be based on information that is unfamiliar to candidates, requiring them to apply the principles and concepts from the syllabus to a new situation, in a logical, deductive way.

AO3 Experimental skills and investigations

Candidates should be able to:

- demonstrate knowledge of how to select and safely use techniques, apparatus and materials (including following a sequence of instructions where appropriate)
- plan experiments and investigations
- make and record observations, measurements and estimates
- interpret and evaluate experimental observations and data
- evaluate methods and suggest possible improvements.

Weighting for assessment objectives

The approximate weightings allocated to each of the assessment objectives (AOs) are summarised below.

Assessment objectives as a percentage of the qualification

Assessment objective	Weighting in IGCSE %
AO1 Knowledge with understanding	50
AO2 Handling information and problem-solving	30
AO3 Experimental skills and investigations	20
Total	100

Assessment objectives as a percentage of each component

Assessment objective	Weighting in components %		
	Papers 1 and 2	Papers 3 and 4	Papers 5 and 6
AO1 Knowledge with understanding	63	63	0
AO2 Handling information and problem-solving	37	37	0
AO3 Experimental skills and investigations	0	0	100
Total	100	100	100

3 Subject content

This syllabus gives you the flexibility to design a course that will interest, challenge and engage your learners. Where appropriate you are responsible for selecting resources and examples to support your learners' study. These should be appropriate for the learners' age, cultural background and learning context as well as complying with your school policies and local legal requirements.

All candidates should be taught the Core subject content. Candidates who are only taught the Core subject content can achieve a maximum of grade C. Candidates aiming for grades A* to C should be taught the Extended subject content. The Extended subject content includes both the Core and the Supplement.

Scientific subjects are, by their nature, experimental. Learners should pursue a fully integrated course which allows them to develop their experimental skills by doing practical work and investigations across a range of topics.

Practical work helps students to:

- use equipment and materials accurately and safely
- develop observational and problem-solving skills
- develop a deeper understanding of the syllabus topics and the scientific approach
- appreciate how scientific theories are developed and tested
- transfer the experimental skills acquired to unfamiliar contexts
- develop positive scientific attitudes such as objectivity, integrity, cooperation, enquiry and inventiveness
- develop an interest and enjoyment in science.

1 Characteristics and classification of living organisms

1.1 Characteristics of living organisms

Core	Supplement
1 Describe the characteristics of living organisms by describing: (a) movement as an action by an organism or part of an organism causing a change of position or place (b) respiration as the chemical reactions in cells that break down nutrient molecules and release energy for metabolism (c) sensitivity as the ability to detect and respond to changes in the internal or external environment (d) growth as a permanent increase in size and dry mass (e) reproduction as the processes that make more of the same kind of organism (f) excretion as the removal of the waste products of metabolism and substances in excess of requirements (g) nutrition as the taking in of materials for energy, growth and development	

1.2 Concept and uses of classification systems

Core

1 State that organisms can be classified into groups by the features that they share

2 Describe a species as a group of organisms that can reproduce to produce fertile offspring

3 Describe the binomial system of naming species as an internationally agreed system in which the scientific name of an organism is made up of two parts showing the genus and species

4 Construct and use dichotomous keys based on identifiable features

Supplement

5 Explain that classification systems aim to reflect evolutionary relationships

6 Explain that the sequences of bases in DNA are used as a means of classification

7 Explain that groups of organisms which share a more recent ancestor (are more closely related) have base sequences in DNA that are more similar than those that share only a distant ancestor

1.3 Features of organisms

Core

1 State the main features used to place animals and plants into the appropriate kingdoms

2 State the main features used to place organisms into groups within the animal kingdom, limited to:

(a) the main groups of vertebrates: mammals, birds, reptiles, amphibians, fish

(b) the main groups of arthropods: myriapods, insects, arachnids, crustaceans

3 Classify organisms using the features identified in 1.3.1 and 1.3.2

Supplement

4 State the main features used to place all organisms into one of the five kingdoms: animal, plant, fungus, prokaryote, protoctist

5 State the main features used to place organisms into groups within the plant kingdom, limited to ferns and flowering plants (dicotyledons and monocotyledons)

6 Classify organisms using the features identified in 1.3.4 and 1.3.5

7 State the features of viruses, limited to a protein coat and genetic material

2 Organisation of the organism

2.1 Cell structure

Core

1 Describe and compare the structure of a plant cell with an animal cell, limited to: cell wall, cell membrane, nucleus, cytoplasm, chloroplasts, ribosomes, mitochondria, vacuoles

2 Describe the structure of a bacterial cell, limited to: cell wall, cell membrane, cytoplasm, ribosomes, circular DNA, plasmids

3 Identify the cell structures listed in 2.1.1 and 2.1.2 in diagrams and images of plant, animal and bacterial cells

4 Describe the functions of the structures listed in 2.1.1 and 2.1.2 in plant, animal and bacterial cells

5 State that new cells are produced by division of existing cells

6 State that specialised cells have specific functions, limited to:

- (a) ciliated cells – movement of mucus in the trachea and bronchi
- (b) root hair cells – absorption
- (c) palisade mesophyll cells – photosynthesis
- (d) neurones – conduction of electrical impulses
- (e) red blood cells – transport of oxygen
- (f) sperm and egg cells (gametes) – reproduction

7 Describe the meaning of the terms: cell, tissue, organ, organ system and organism as illustrated by examples given in the syllabus

Supplement

2.2 Size of specimens

Core

1 State and use the formula:
magnification = image size ÷ actual size

2 Calculate magnification and size of biological specimens using millimetres as units

Supplement

3 Convert measurements between millimetres (mm) and micrometres (μm)

3 Movement into and out of cells

3.1 Diffusion

Core

1 Describe diffusion as the net movement of particles from a region of their higher concentration to a region of their lower concentration (i.e. down a concentration gradient), as a result of their random movement

2 State that the energy for diffusion comes from the kinetic energy of random movement of molecules and ions

3 State that some substances move into and out of cells by diffusion through the cell membrane

4 Describe the importance of diffusion of gases and solutes in living organisms

5 Investigate the factors that influence diffusion, limited to: surface area, temperature, concentration gradient and distance

Supplement

3.2 Osmosis

Core

1 Describe the role of water as a solvent in organisms with reference to digestion, excretion and transport

2 State that water diffuses through partially permeable membranes by osmosis

3 State that water moves into and out of cells by osmosis through the cell membrane

4 Investigate osmosis using materials such as dialysis tubing

5 Investigate and describe the effects on plant tissues of immersing them in solutions of different concentrations

6 State that plants are supported by the pressure of water inside the cells pressing outwards on the cell wall

Supplement

7 Describe osmosis as the net movement of water molecules from a region of higher water potential (dilute solution) to a region of lower water potential (concentrated solution), through a partially permeable membrane

8 Explain the effects on plant cells of immersing them in solutions of different concentrations by using the terms: turgid, turgor pressure, plasmolysis, flaccid

9 Explain the importance of water potential and osmosis in the uptake and loss of water by organisms

3.3 Active transport

Core

1 Describe active transport as the movement of particles through a cell membrane from a region of lower concentration to a region of higher concentration (i.e. against a concentration gradient), using energy from respiration

Supplement

2 Explain the importance of active transport as a process for movement of molecules or ions across membranes, including ion uptake by root hairs

3 State that protein carriers move molecules or ions across a membrane during active transport

4 Biological molecules

4.1 Biological molecules

Core

1 List the chemical elements that make up: carbohydrates, fats and proteins

2 State that large molecules are made from smaller molecules, limited to:
   (a) starch, glycogen and cellulose from glucose
   (b) proteins from amino acids
   (c) fats and oils from fatty acids and glycerol

3 Describe the use of:
   (a) iodine solution test for starch
   (b) Benedict's solution test for reducing sugars
   (c) biuret test for proteins
   (d) ethanol emulsion test for fats and oils
   (e) DCPIP test for vitamin C

Supplement

4 Describe the structure of a DNA molecule:
   (a) two strands coiled together to form a double helix
   (b) each strand contains chemicals called bases
   (c) bonds between pairs of bases hold the strands together
   (d) the bases always pair up in the same way: A with T, and C with G (full names are **not** required)

5 Enzymes

5.1 Enzymes

Core	Supplement
1 Describe a catalyst as a substance that increases the rate of a chemical reaction and is not changed by the reaction	
2 Describe enzymes as proteins that are involved in all metabolic reactions, where they function as biological catalysts	
3 Describe why enzymes are important in all living organisms in terms of a reaction rate necessary to sustain life	
4 Describe enzyme action with reference to the shape of the active site of an enzyme being complementary to its substrate and the formation of products	6 Explain enzyme action with reference to: active site, enzyme-substrate complex, substrate and product
	7 Explain the specificity of enzymes in terms of the complementary shape and fit of the active site with the substrate
5 Investigate and describe the effect of changes in temperature and pH on enzyme activity with reference to optimum temperature and denaturation	8 Explain the effect of changes in temperature on enzyme activity in terms of kinetic energy, shape and fit, frequency of effective collisions and denaturation
	9 Explain the effect of changes in pH on enzyme activity in terms of shape and fit and denaturation

6 Plant nutrition

6.1 Photosynthesis

Core	Supplement
1 Describe photosynthesis as the process by which plants synthesise carbohydrates from raw materials using energy from light	
2 State the word equation for photosynthesis as: carbon dioxide + water → glucose + oxygen in the presence of light and chlorophyll	10 State the balanced chemical equation for photosynthesis as: $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$
3 State that chlorophyll is a green pigment that is found in chloroplasts	
4 State that chlorophyll transfers energy from light into energy in chemicals, for the synthesis of carbohydrates	

continued

6.1 Photosynthesis continued

Core

5 Outline the subsequent use and storage of the carbohydrates made in photosynthesis, limited to:
   (a) starch as an energy store
   (b) cellulose to build cell walls
   (c) glucose used in respiration to provide energy
   (d) sucrose for transport in the phloem
   (e) nectar to attract insects for pollination

6 Explain the importance of:
   (a) nitrate ions for making amino acids
   (b) magnesium ions for making chlorophyll

7 Investigate the need for chlorophyll, light and carbon dioxide for photosynthesis, using appropriate controls

8 Investigate and describe the effects of varying light intensity, carbon dioxide concentration and temperature on the rate of photosynthesis

9 Investigate and describe the effect of light and dark conditions on gas exchange in an aquatic plant using hydrogencarbonate indicator solution

Supplement

11 Identify and explain the limiting factors of photosynthesis in different environmental conditions

6.2 Leaf structure

Core

1 State that most leaves have a large surface area and are thin, and explain how these features are adaptations for photosynthesis

2 Identify in diagrams and images the following structures in the leaf of a dicotyledonous plant: chloroplasts, cuticle, guard cells and stomata, upper and lower epidermis, palisade mesophyll, spongy mesophyll, air spaces, vascular bundles, xylem and phloem

3 Explain how the structures listed in 6.2.2 adapt leaves for photosynthesis

Supplement

7 Human nutrition

7.1 Diet

Core

1 Describe what is meant by a balanced diet

2 State the principal dietary sources and describe the importance of:
   (a) carbohydrates
   (b) fats and oils
   (c) proteins
   (d) vitamins, limited to C and D
   (e) mineral ions, limited to calcium and iron
   (f) fibre (roughage)
   (g) water

3 State the causes of scurvy and rickets

Supplement

7.2 Digestive system

Core

1 Identify in diagrams and images the main organs of the digestive system, limited to:
   (a) alimentary canal: mouth, oesophagus, stomach, small intestine (duodenum and ileum) and large intestine (colon, rectum, anus)
   (b) associated organs: salivary glands, pancreas, liver and gall bladder

2 Describe the functions of the organs of the digestive system listed in 7.2.1, in relation to:
   (a) ingestion – the taking of substances, e.g. food and drink, into the body
   (b) digestion – the breakdown of food
   (c) absorption – the movement of nutrients from the intestines into the blood
   (d) assimilation – uptake and use of nutrients by cells
   (e) egestion – the removal of undigested food from the body as faeces

Supplement

7.3 Physical digestion

Core

1 Describe physical digestion as the breakdown of food into smaller pieces without chemical change to the food molecules

2 State that physical digestion increases the surface area of food for the action of enzymes in chemical digestion

3 Identify in diagrams and images the types of human teeth: incisors, canines, premolars and molars

4 Describe the structure of human teeth, limited to: enamel, dentine, pulp, nerves, blood vessels and cement, and understand that teeth are embedded in bone and the gums

5 Describe the functions of the types of human teeth in physical digestion of food

6 Describe the function of the stomach in physical digestion

Supplement

7 Outline the role of bile in emulsifying fats and oils to increase the surface area for chemical digestion

7.4 Chemical digestion

Core

1 Describe chemical digestion as the breakdown of large insoluble molecules into small soluble molecules

2 State the role of chemical digestion in producing small soluble molecules that can be absorbed

3 Describe the functions of enzymes as follows:
- (a) amylase breaks down starch to simple reducing sugars
- (b) proteases break down protein to amino acids
- (c) lipase breaks down fats and oils to fatty acids and glycerol

4 State where, in the digestive system, amylase, protease and lipase are secreted and where they act

5 Describe the functions of hydrochloric acid in gastric juice, limited to killing harmful microorganisms in food and providing an acidic pH for optimum enzyme activity

Supplement

6 Describe the digestion of starch in the digestive system:
- (a) amylase breaks down starch to maltose
- (b) maltase breaks down maltose to glucose on the membranes of the epithelium lining the small intestine

7 Describe the digestion of protein by proteases in the digestive system:
- (a) pepsin breaks down protein in the acidic conditions of the stomach
- (b) trypsin breaks down protein in the alkaline conditions of the small intestine

8 Explain that bile is an alkaline mixture that neutralises the acidic mixture of food and gastric juices entering the duodenum from the stomach, to provide a suitable pH for enzyme action

7.5 Absorption

Core

1 State that the small intestine is the region where nutrients are absorbed

2 State that most water is absorbed from the small intestine but that some is also absorbed from the colon

Supplement

3 Explain the significance of villi and microvilli in increasing the internal surface area of the small intestine

4 Describe the structure of a villus

5 Describe the roles of capillaries and lacteals in villi

8 Transport in plants

8.1 Xylem and phloem

Core

1 State the functions of xylem and phloem:
   (a) xylem – transport of water and mineral ions, and support
   (b) phloem – transport of sucrose and amino acids
2 Identify in diagrams and images the position of xylem and phloem as seen in sections of roots, stems and leaves of non-woody dicotyledonous plants

Supplement

3 Relate the structure of xylem vessels to their function, limited to:
   (a) thick walls with lignin (details of lignification are **not** required)
   (b) no cell contents
   (c) cells joined end to end with no cross walls to form a long continuous tube

8.2 Water uptake

Core

1 Identify in diagrams and images root hair cells and state their functions
2 State that the large surface area of root hairs increases the uptake of water and mineral ions
3 Outline the pathway taken by water through the root, stem and leaf as: root hair cells, root cortex cells, xylem, mesophyll cells
4 Investigate, using a suitable stain, the pathway of water through the above-ground parts of a plant

Supplement

8.3 Transpiration

Core	Supplement
1 Describe transpiration as the loss of water vapour from leaves	
2 State that water evaporates from the surfaces of the mesophyll cells into the air spaces and then diffuses out of the leaves through the stomata as water vapour	
	4 Explain how water vapour loss is related to: the large internal surface area provided by the interconnecting air spaces between mesophyll cells and the size and number of stomata
	5 Explain the mechanism by which water moves upwards in the xylem in terms of a transpiration pull that draws up a column of water molecules, held together by forces of attraction between water molecules
3 Investigate and describe the effects of variation of temperature and wind speed on transpiration rate	6 Explain the effects on the rate of transpiration of varying the following factors: temperature, wind speed and humidity
	7 Explain how and why wilting occurs

8.4 Translocation

Core	Supplement
	1 Describe translocation as the movement of sucrose and amino acids in phloem from sources to sinks
	2 Describe: (a) sources as the parts of plants that release sucrose or amino acids (b) sinks as the parts of plants that use or store sucrose or amino acids
	3 Explain why some parts of a plant may act as a source and a sink at different times

9 Transport in animals

9.1 Circulatory systems

Core

1 Describe the circulatory system as a system of blood vessels with a pump and valves to ensure one-way flow of blood

Supplement

2 Describe the single circulation of a fish

3 Describe the double circulation of a mammal

4 Explain the advantages of a double circulation

9.2 Heart

Core

1 Identify in diagrams and images the structures of the mammalian heart, limited to: muscular wall, septum, left and right ventricles, left and right atria, one-way valves and coronary arteries

2 State that blood is pumped away from the heart in arteries and returns to the heart in veins

3 State that the activity of the heart may be monitored by: ECG, pulse rate and listening to sounds of valves closing

4 Investigate and describe the effect of physical activity on the heart rate

5 Describe coronary heart disease in terms of the blockage of coronary arteries and state the possible risk factors including: diet, lack of exercise, stress, smoking, genetic predisposition, age and sex

6 Discuss the roles of diet and exercise in reducing the risk of coronary heart disease

Supplement

7 Identify in diagrams and images the atrioventricular and semilunar valves in the mammalian heart

8 Explain the relative thickness of:

(a) the muscle walls of the left and right ventricles

(b) the muscle walls of the atria compared to those of the ventricles

9 Explain the importance of the septum in separating oxygenated and deoxygenated blood

10 Describe the functioning of the heart in terms of the contraction of muscles of the atria and ventricles and the action of the valves

11 Explain the effect of physical activity on the heart rate

9.3 Blood vessels

Core

1 Describe the structure of arteries, veins and capillaries, limited to: relative thickness of wall, diameter of the lumen and the presence of valves in veins

2 State the functions of capillaries

3 Identify in diagrams and images the main blood vessels to and from the:
- (a) heart, limited to: vena cava, aorta, pulmonary artery and pulmonary vein
- (b) lungs, limited to: pulmonary artery and pulmonary vein
- (c) kidney, limited to: renal artery and renal vein

Supplement

4 Explain how the structure of arteries and veins is related to the pressure of the blood that they transport

5 Explain how the structure of capillaries is related to their functions

6 Identify, in diagrams and images, the main blood vessels to and from the liver as: hepatic artery, hepatic veins and hepatic portal vein

9.4 Blood

Core

1 List the components of blood as: red blood cells, white blood cells, platelets and plasma

2 Identify red and white blood cells in photomicrographs and diagrams

3 State the functions of the following components of blood:
- (a) red blood cells in transporting oxygen, including the role of haemoglobin
- (b) white blood cells in phagocytosis and antibody production
- (c) platelets in clotting (details are **not** required)
- (d) plasma in the transport of blood cells, ions, nutrients, urea, hormones and carbon dioxide

4 State the roles of blood clotting as preventing blood loss and the entry of pathogens

Supplement

5 Identify lymphocytes and phagocytes in photomicrographs and diagrams

6 State the functions of:
- (a) lymphocytes – antibody production
- (b) phagocytes – engulfing pathogens by phagocytosis

7 Describe the process of clotting as the conversion of fibrinogen to fibrin to form a mesh

10 Diseases and immunity

10.1 Diseases and immunity

Core

1 Describe a pathogen as a disease-causing organism

2 Describe a transmissible disease as a disease in which the pathogen can be passed from one host to another

3 State that a pathogen is transmitted:
- (a) by direct contact, including through blood and other body fluids
- (b) indirectly, including from contaminated surfaces, food, animals and air

4 Describe the body defences, limited to: skin, hairs in the nose, mucus, stomach acid and white blood cells

5 Explain the importance of the following in controlling the spread of disease:
- (a) a clean water supply
- (b) hygienic food preparation
- (c) good personal hygiene
- (d) waste disposal
- (e) sewage treatment (details of the stages of sewage treatment are **not** required)

Supplement

6 Describe active immunity as defence against a pathogen by antibody production in the body

7 State that each pathogen has its own antigens, which have specific shapes

8 Describe antibodies as proteins that bind to antigens leading to direct destruction of pathogens or marking of pathogens for destruction by phagocytes

9 State that specific antibodies have complementary shapes which fit specific antigens

10 Explain that active immunity is gained after an infection by a pathogen or by vaccination

11 Outline the process of vaccination:
- (a) weakened pathogens or their antigens are put into the body
- (b) the antigens stimulate an immune response by lymphocytes which produce antibodies
- (c) memory cells are produced that give long-term immunity

12 Explain the role of vaccination in controlling the spread of diseases

13 Explain that passive immunity is a short-term defence against a pathogen by antibodies acquired from another individual, including across the placenta and in breast milk

14 Explain the importance of breast-feeding for the development of passive immunity in infants

15 State that memory cells are not produced in passive immunity

continued

10.1 Diseases and immunity continued

Core	Supplement
	16 Describe cholera as a disease caused by a bacterium which is transmitted in contaminated water
	17 Explain that the cholera bacterium produces a toxin that causes secretion of chloride ions into the small intestine, causing osmotic movement of water into the gut, causing diarrhoea, dehydration and loss of ions from the blood

11 Gas exchange in humans

11.1 Gas exchange in humans

Core	Supplement
1 Describe the features of gas exchange surfaces in humans, limited to: large surface area, thin surface, good blood supply and good ventilation with air	
2 Identify in diagrams and images the following parts of the breathing system: lungs, diaphragm, ribs, intercostal muscles, larynx, trachea, bronchi, bronchioles, alveoli and associated capillaries	6 Identify in diagrams and images the internal and external intercostal muscles
	7 State the function of cartilage in the trachea
	8 Explain the role of the ribs, the internal and external intercostal muscles and the diaphragm in producing volume and pressure changes in the thorax leading to the ventilation of the lungs
3 Investigate the differences in composition between inspired and expired air using limewater as a test for carbon dioxide	9 Explain the differences in composition between inspired and expired air
4 Describe the differences in composition between inspired and expired air, limited to: oxygen, carbon dioxide and water vapour	
5 Investigate and describe the effects of physical activity on the rate and depth of breathing	10 Explain the link between physical activity and the rate and depth of breathing in terms of: an increased carbon dioxide concentration in the blood, which is detected by the brain, leading to an increased rate and greater depth of breathing
	11 Explain the role of goblet cells, mucus and ciliated cells in protecting the breathing system from pathogens and particles

12 Respiration

12.1 Respiration

Core	Supplement
1 State the uses of energy in living organisms, including: muscle contraction, protein synthesis, cell division, active transport, growth, the passage of nerve impulses and the maintenance of a constant body temperature	
2 Investigate and describe the effect of temperature on respiration in yeast	

12.2 Aerobic respiration

Core	Supplement
1 Describe aerobic respiration as the chemical reactions in cells that use oxygen to break down nutrient molecules to release energy	
2 State the word equation for aerobic respiration as: glucose + oxygen → carbon dioxide + water	3 State the balanced chemical equation for aerobic respiration as: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

12.3 Anaerobic respiration

Core	Supplement
1 Describe anaerobic respiration as the chemical reactions in cells that break down nutrient molecules to release energy without using oxygen	
2 State that anaerobic respiration releases much less energy per glucose molecule than aerobic respiration	
3 State the word equation for anaerobic respiration in yeast as: glucose → alcohol + carbon dioxide	5 State the balanced chemical equation for anaerobic respiration in yeast as: $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$
4 State the word equation for anaerobic respiration in muscles during vigorous exercise as: glucose → lactic acid	6 State that lactic acid builds up in muscles and blood during vigorous exercise causing an oxygen debt

continued

12.3 Anaerobic respiration continued

Core	Supplement
	7 Outline how the oxygen debt is removed after exercise, limited to: (a) continuation of fast heart rate to transport lactic acid in the blood from the muscles to the liver (b) continuation of deeper and faster breathing to supply oxygen for aerobic respiration of lactic acid (c) aerobic respiration of lactic acid in the liver

13 Excretion in humans

13.1 Excretion in humans

Core	Supplement
1 State that carbon dioxide is excreted through the lungs	
2 State that the kidneys excrete urea and excess water and ions	
3 Identify in diagrams and images the kidneys, ureters, bladder and urethra	4 Identify in diagrams and images the structure of the kidney, limited to the cortex and medulla 5 Outline the structure and function of a nephron and its associated blood vessels, limited to: (a) the role of the glomerulus in the filtration from the blood of water, glucose, urea and ions (b) the role of the nephron in the reabsorption of all of the glucose, some of the ions and most of the water back into the blood (c) the formation of urine containing urea, excess water and excess ions (details of these processes are **not** required) 6 Describe the role of the liver in the assimilation of amino acids by converting them to proteins 7 State that urea is formed in the liver from excess amino acids 8 Describe deamination as the removal of the nitrogen-containing part of amino acids to form urea 9 Explain the importance of excretion, limited to toxicity of urea

14 Coordination and response

14.1 Coordination and response

Core

1 State that electrical impulses travel along neurones

2 Describe the mammalian nervous system in terms of:

(a) the central nervous system (CNS) consisting of the brain and the spinal cord

(b) the peripheral nervous system (PNS) consisting of the nerves outside of the brain and spinal cord

3 Describe the role of the nervous system as coordination and regulation of body functions

4 Identify in diagrams and images sensory, relay and motor neurones

5 Describe a simple reflex arc in terms of: receptor, sensory neurone, relay neurone, motor neurone and effector

6 Describe a reflex action as a means of automatically and rapidly integrating and coordinating stimuli with the responses of effectors (muscles and glands)

7 Describe a synapse as a junction between two neurones

Supplement

8 Describe the structure of a synapse, including the presence of vesicles containing neurotransmitter molecules, the synaptic gap and receptor proteins

9 Describe the events at a synapse as:

(a) an impulse stimulates the release of neurotransmitter molecules from vesicles into the synaptic gap

(b) the neurotransmitter molecules diffuse across the gap

(c) neurotransmitter molecules bind with receptor proteins on the next neurone

(d) an impulse is then stimulated in the next neurone

10 State that synapses ensure that impulses travel in one direction only

14.2 Sense organs

Core

1 Describe sense organs as groups of receptor cells responding to specific stimuli: light, sound, touch, temperature and chemicals

2 Identify in diagrams and images the structures of the eye, limited to: cornea, iris, pupil, lens, retina, optic nerve and blind spot

3 Describe the function of each part of the eye, limited to:

- (a) cornea – refracts light
- (b) iris – controls how much light enters the pupil
- (c) lens – focuses light on to the retina
- (d) retina – contains light receptors, some sensitive to light of different colours
- (e) optic nerve – carries impulses to the brain

4 Explain the pupil reflex, limited to changes in light intensity and pupil diameter

Supplement

5 Explain the pupil reflex in terms of the antagonistic action of circular and radial muscles in the iris

6 Explain accommodation to view near and distant objects in terms of the contraction and relaxation of the ciliary muscles, tension in the suspensory ligaments, shape of the lens and refraction of light

7 Describe the distribution of rods and cones in the retina of a human

8 Outline the function of rods and cones, limited to:

- (a) greater sensitivity of rods for night vision
- (b) three different kinds of cones, absorbing light of different colours, for colour vision

9 Identify in diagrams and images the position of the fovea and state its function

14.3 Hormones

Core

1 Describe a hormone as a chemical substance, produced by a gland and carried by the blood, which alters the activity of one or more specific target organs

2 Identify in diagrams and images specific endocrine glands and state the hormones they secrete, limited to:
- (a) adrenal glands and adrenaline
- (b) pancreas and insulin
- (c) testes and testosterone
- (d) ovaries and oestrogen

3 Describe adrenaline as the hormone secreted in 'fight or flight' situations and its effects, limited to:
- (a) increased breathing rate
- (b) increased heart rate
- (c) increased pupil diameter

4 Compare nervous and hormonal control, limited to speed of action and duration of effect

Supplement

5 State that glucagon is secreted by the pancreas

6 Describe the role of adrenaline in the control of metabolic activity, limited to:
- (a) increasing the blood glucose concentration
- (b) increasing heart rate

14.4 Homeostasis

Core

1 Describe homeostasis as the maintenance of a constant internal environment

2 State that insulin decreases blood glucose concentration

Supplement

3 Explain the concept of homeostatic control by negative feedback with reference to a set point

4 Describe the control of blood glucose concentration by the liver and the roles of insulin and glucagon

5 Outline the treatment of Type 1 diabetes

6 Identify in diagrams and images of the skin: hairs, hair erector muscles, sweat glands, receptors, sensory neurones, blood vessels and fatty tissue

7 Describe the maintenance of a constant internal body temperature in mammals in terms of: insulation, sweating, shivering and the role of the brain

8 Describe the maintenance of a constant internal body temperature in mammals in terms of vasodilation and vasoconstriction of arterioles supplying skin surface capillaries

14.5 Tropic responses

Core

1 Describe gravitropism as a response in which parts of a plant grow towards or away from gravity
2 Describe phototropism as a response in which parts of a plant grow towards or away from the direction of the light source
3 Investigate and describe gravitropism and phototropism in shoots and roots

Supplement

4 Explain phototropism and gravitropism of a shoot as examples of the chemical control of plant growth
5 Explain the role of auxin in controlling shoot growth, limited to:
   (a) auxin is made in the shoot tip
   (b) auxin diffuses through the plant from the shoot tip
   (c) auxin is unequally distributed in response to light and gravity
   (d) auxin stimulates cell elongation

15 Drugs

15.1 Drugs

Core

1 Describe a drug as any substance taken into the body that modifies or affects chemical reactions in the body
2 Describe the use of antibiotics for the treatment of bacterial infections
3 State that some bacteria are resistant to antibiotics which reduces the effectiveness of antibiotics
4 State that antibiotics kill bacteria but do not affect viruses

Supplement

5 Explain how using antibiotics only when essential can limit the development of resistant bacteria such as MRSA

16 Reproduction

16.1 Asexual reproduction

Core

1 Describe asexual reproduction as a process resulting in the production of genetically identical offspring from one parent
2 Identify examples of asexual reproduction in diagrams, images and information provided

Supplement

3 Discuss the advantages and disadvantages of asexual reproduction:
   (a) to a population of a species in the wild
   (b) to crop production

16.2 Sexual reproduction

Core

1 Describe sexual reproduction as a process involving the fusion of the nuclei of two gametes to form a zygote and the production of offspring that are genetically different from each other

2 Describe fertilisation as the fusion of the nuclei of gametes

Supplement

3 State that nuclei of gametes are haploid and that the nucleus of a zygote is diploid

4 Discuss the advantages and disadvantages of sexual reproduction:
- (a) to a population of a species in the wild
- (b) to crop production

16.3 Sexual reproduction in plants

Core

1 Identify in diagrams and images and draw the following parts of an insect-pollinated flower: sepals, petals, stamens, filaments, anthers, carpels, style, stigma, ovary and ovules

2 State the functions of the structures listed in 16.3.1

3 Identify in diagrams and images and describe the anthers and stigmas of a wind-pollinated flower

4 Distinguish between the pollen grains of insect-pollinated and wind-pollinated flowers

5 Describe pollination as the transfer of pollen grains from an anther to a stigma

Supplement

9 Describe self-pollination as the transfer of pollen grains from the anther of a flower to the stigma of the same flower or a different flower on the same plant

10 Describe cross-pollination as the transfer of pollen grains from the anther of a flower to the stigma of a flower on a different plant of the same species

11 Discuss the potential effects of self-pollination and cross-pollination on a population, in terms of variation, capacity to respond to changes in the environment and reliance on pollinators

continued

16.3 Sexual reproduction in plants continued

Core

6 State that fertilisation occurs when a pollen nucleus fuses with a nucleus in an ovule

7 Describe the structural adaptations of insect-pollinated and wind-pollinated flowers

8 Investigate and describe the environmental conditions that affect germination of seeds, limited to the requirement for: water, oxygen and a suitable temperature

Supplement

12 Describe the growth of the pollen tube and its entry into the ovule followed by fertilisation (details of production of endosperm and development are **not** required)

16.4 Sexual reproduction in humans

Core

1 Identify on diagrams and state the functions of the following parts of the male reproductive system: testes, scrotum, sperm ducts, prostate gland, urethra and penis

2 Identify on diagrams and state the functions of the following parts of the female reproductive system: ovaries, oviducts, uterus, cervix and vagina

3 Describe fertilisation as the fusion of the nuclei from a male gamete (sperm) and a female gamete (egg cell)

4 Explain the adaptive features of sperm, limited to: flagellum, mitochondria and enzymes in the acrosome

5 Explain the adaptive features of egg cells, limited to: energy stores and the jelly coat that changes at fertilisation

6 Compare male and female gametes in terms of: size, structure, motility and numbers

7 State that in early development, the zygote forms an embryo which is a ball of cells that implants into the lining of the uterus

8 Identify on diagrams and state the functions of the following in the development of the fetus: umbilical cord, placenta, amniotic sac and amniotic fluid

Supplement

9 Describe the function of the placenta and umbilical cord in relation to the exchange of dissolved nutrients, gases and excretory products between the blood of the mother and the blood of the fetus

10 State that some pathogens and toxins can pass across the placenta and affect the fetus

16.5 Sex hormones in humans

Core	Supplement
1 Describe the roles of testosterone and oestrogen in the development and regulation of secondary sexual characteristics during puberty	
2 Describe the menstrual cycle in terms of changes in the ovaries and in the lining of the uterus	3 Describe the sites of production of oestrogen and progesterone in the menstrual cycle and in pregnancy 4 Explain the role of hormones in controlling the menstrual cycle and pregnancy, limited to FSH, LH, progesterone and oestrogen

16.6 Sexually transmitted infections

Core	Supplement
1 Describe a sexually transmitted infection (STI) as an infection that is transmitted through sexual contact 2 State that human immunodeficiency virus (HIV) is a pathogen that causes an STI 3 State that HIV infection may lead to AIDS 4 Describe the methods of transmission of HIV 5 Explain how the spread of STIs is controlled	

17 Inheritance

17.1 Chromosomes, genes and proteins

Core	Supplement
1 State that chromosomes are made of DNA, which contains genetic information in the form of genes 2 Define a gene as a length of DNA that codes for a protein 3 Define an allele as an alternative form of a gene 4 Describe the inheritance of sex in humans with reference to X and Y chromosomes	5 State that the sequence of bases in a gene determines the sequence of amino acids used to make a specific protein (knowledge of the details of nucleotide structure is **not** required) 6 Explain that different sequences of amino acids give different shapes to protein molecules

continued

17.1 Chromosomes, genes and proteins continued

Core

Supplement

7 Explain that DNA controls cell function by controlling the production of proteins, including enzymes, membrane carriers and receptors for neurotransmitters

8 Explain how a protein is made, limited to:

- the gene coding for the protein remains in the nucleus
- messenger RNA (mRNA) is a copy of a gene
- mRNA molecules are made in the nucleus and move to the cytoplasm
- the mRNA passes through ribosomes
- the ribosome assembles amino acids into protein molecules
- the specific sequence of amino acids is determined by the sequence of bases in the mRNA

(knowledge of the details of transcription or translation is **not** required)

9 Explain that most body cells in an organism contain the same genes, but many genes in a particular cell are not expressed because the cell only makes the specific proteins it needs

10 Describe a haploid nucleus as a nucleus containing a single set of chromosomes

11 Describe a diploid nucleus as a nucleus containing two sets of chromosomes

12 State that in a diploid cell, there is a pair of each type of chromosome and in a human diploid cell there are 23 pairs

17.2 Mitosis

Core

Supplement

1 Describe mitosis as nuclear division giving rise to genetically identical cells (details of the stages of mitosis are **not** required)
2 State the role of mitosis in growth, repair of damaged tissues, replacement of cells and asexual reproduction
3 State that the exact replication of chromosomes occurs before mitosis
4 State that during mitosis, the copies of chromosomes separate, maintaining the chromosome number in each daughter cell
5 Describe stem cells as unspecialised cells that divide by mitosis to produce daughter cells that can become specialised for specific functions

17.3 Meiosis

Core

Supplement

1 State that meiosis is involved in the production of gametes
2 Describe meiosis as a reduction division in which the chromosome number is halved from diploid to haploid resulting in genetically different cells (details of the stages of meiosis are **not** required)

17.4 Monohybrid inheritance

Core

1 Describe inheritance as the transmission of genetic information from generation to generation

2 Describe genotype as the genetic make-up of an organism and in terms of the alleles present

3 Describe phenotype as the observable features of an organism

4 Describe homozygous as having two identical alleles of a particular gene

5 State that two identical homozygous individuals that breed together will be pure-breeding

6 Describe heterozygous as having two different alleles of a particular gene

7 State that a heterozygous individual will not be pure-breeding

8 Describe a dominant allele as an allele that is expressed if it is present in the genotype

9 Describe a recessive allele as an allele that is only expressed when there is no dominant allele of the gene present in the genotype

10 Interpret pedigree diagrams for the inheritance of a given characteristic

11 Use genetic diagrams to predict the results of monohybrid crosses and calculate phenotypic ratios, limited to 1 : 1 and 3 : 1 ratios

12 Use Punnett squares in crosses which result in more than one genotype to work out and show the possible different genotypes

Supplement

13 Explain how to use a test cross to identify an unknown genotype

14 Describe codominance as a situation in which both alleles in heterozygous organisms contribute to the phenotype

15 Explain the inheritance of ABO blood groups: phenotypes are A, B, AB and O blood groups and alleles are I^A, I^B and I^o

16 Describe a sex-linked characteristic as a feature in which the gene responsible is located on a sex chromosome and that this makes the characteristic more common in one sex than in the other

17 Describe red-green colour blindness as an example of sex linkage

18 Use genetic diagrams to predict the results of monohybrid crosses involving codominance or sex linkage and calculate phenotypic ratios

18 Variation and selection

18.1 Variation

Core	Supplement
1 Describe variation as differences between individuals of the same species	
2 State that continuous variation results in a range of phenotypes between two extremes; examples include body length and body mass	
3 State that discontinuous variation results in a limited number of phenotypes with no intermediates; examples include ABO blood groups, seed shape in peas and seed colour in peas	
4 State that discontinuous variation is usually caused by genes only and continuous variation is caused by both genes and the environment	
5 Investigate and describe examples of continuous and discontinuous variation	
6 Describe mutation as genetic change	9 Describe gene mutation as a random change in the base sequence of DNA
7 State that mutation is the way in which new alleles are formed	10 State that mutation, meiosis, random mating and random fertilisation are sources of genetic variation in populations
8 State that ionising radiation and some chemicals increase the rate of mutation	

18.2 Adaptive features

Core	Supplement
1 Describe an adaptive feature as an inherited feature that helps an organism to survive and reproduce in its environment	
2 Interpret images or other information about a species to describe its adaptive features	
	3 Explain the adaptive features of hydrophytes and xerophytes to their environments

18.3 Selection

Core	Supplement
1 Describe natural selection with reference to: (a) genetic variation within populations (b) production of many offspring (c) struggle for survival, including competition for resources (d) a greater chance of reproduction by individuals that are better adapted to the environment than others (e) these individuals pass on their alleles to the next generation	4 Describe adaptation as the process, resulting from natural selection, by which populations become more suited to their environment over many generations
	5 Describe the development of strains of antibiotic resistant bacteria as an example of natural selection
2 Describe selective breeding with reference to: (a) selection by humans of individuals with desirable features (b) crossing these individuals to produce the next generation (c) selection of offspring showing the desirable features	
3 Outline how selective breeding by artificial selection is carried out over many generations to improve crop plants and domesticated animals and apply this to given contexts	6 Outline the differences between natural and artificial selection

19 Organisms and their environment

19.1 Energy flow

Core	Supplement
1 State that the Sun is the principal source of energy input to biological systems	
2 Describe the flow of energy through living organisms, including light energy from the Sun and chemical energy in organisms, and its eventual transfer to the environment	

19.2 Food chains and food webs

Core

1 Describe a food chain as showing the transfer of energy from one organism to the next, beginning with a producer

2 Construct and interpret simple food chains

3 Describe a food web as a network of interconnected food chains and interpret food webs

4 Describe a producer as an organism that makes its own organic nutrients, usually using energy from sunlight, through photosynthesis

5 Describe a consumer as an organism that gets its energy by feeding on other organisms

6 State that consumers may be classed as primary, secondary, tertiary and quaternary according to their position in a food chain

7 Describe a herbivore as an animal that gets its energy by eating plants

8 Describe a carnivore as an animal that gets its energy by eating other animals

9 Describe a decomposer as an organism that gets its energy from dead or waste organic material

10 Use food chains and food webs to describe the impact humans have through overharvesting of food species and through introducing foreign species to a habitat

11 Draw, describe and interpret pyramids of numbers and pyramids of biomass

12 Discuss the advantages of using a pyramid of biomass rather than a pyramid of numbers to represent a food chain

13 Describe a trophic level as the position of an organism in a food chain, food web or ecological pyramid

14 Identify the following as the trophic levels in food webs, food chains and ecological pyramids: producers, primary consumers, secondary consumers, tertiary consumers and quaternary consumers

Supplement

15 Draw, describe and interpret pyramids of energy

16 Discuss the advantages of using a pyramid of energy rather than pyramids of numbers or biomass to represent a food chain

17 Explain why the transfer of energy from one trophic level to another is often not efficient

18 Explain, in terms of energy loss, why food chains usually have fewer than five trophic levels

19 Explain why it is more energy efficient for humans to eat crop plants than to eat livestock that have been fed on crop plants

19.3 Nutrient cycles

Core

1 Describe the carbon cycle, limited to: photosynthesis, respiration, feeding, decomposition, formation of fossil fuels and combustion

Supplement

2 Describe the nitrogen cycle with reference to:
- decomposition of plant and animal protein to ammonium ions
- nitrification
- nitrogen fixation by lightning and bacteria
- absorption of nitrate ions by plants
- production of amino acids and proteins
- feeding and digestion of proteins
- deamination
- denitrification

3 State the roles of microorganisms in the nitrogen cycle, limited to: decomposition, nitrification, nitrogen fixation and denitrification (generic names of individual bacteria, e.g. *Rhizobium*, are **not** required)

19.4 Populations

Core

1 Describe a population as a group of organisms of one species, living in the same area, at the same time

2 Describe a community as all of the populations of different species in an ecosystem

3 Describe an ecosystem as a unit containing the community of organisms and their environment, interacting together

4 Identify and state the factors affecting the rate of population growth for a population of an organism, limited to food supply, competition, predation and disease

5 Identify the lag, exponential (log), stationary and death phases in the sigmoid curve of population growth for a population growing in an environment with limited resources

6 Interpret graphs and diagrams of population growth

Supplement

7 Explain the factors that lead to each phase in the sigmoid curve of population growth, making reference, where appropriate, to the role of limiting factors

20 Human influences on ecosystems

20.1 Food supply

Core

1 Describe how humans have increased food production, limited to:
   (a) agricultural machinery to use larger areas of land and improve efficiency
   (b) chemical fertilisers to improve yields
   (c) insecticides to improve quality and yield
   (d) herbicides to reduce competition with weeds
   (e) selective breeding to improve production by crop plants and livestock
2 Describe the advantages and disadvantages of large-scale monocultures of crop plants
3 Describe the advantages and disadvantages of intensive livestock production

Supplement

20.2 Habitat destruction

Core

1 Describe biodiversity as the number of different species that live in an area
2 Describe the reasons for habitat destruction, including:
   (a) increased area for housing, crop plant production and livestock production
   (b) extraction of natural resources
   (c) freshwater and marine pollution
3 State that through altering food webs and food chains, humans can have a negative impact on habitats
4 Explain the undesirable effects of deforestation as an example of habitat destruction, to include: reducing biodiversity, extinction, loss of soil, flooding and increase of carbon dioxide in the atmosphere

Supplement

20.3 Pollution

Core

1 Describe the effects of untreated sewage and excess fertiliser on aquatic ecosystems

2 Describe the effects of non-biodegradable plastics, in both aquatic and terrestrial ecosystems

3 Describe the sources and effects of pollution of the air by methane and carbon dioxide, limited to: the enhanced greenhouse effect and climate change

Supplement

4 Explain the process of eutrophication of water, limited to:

- increased availability of nitrate and other ions
- increased growth of producers
- increased decomposition after death of producers
- increased aerobic respiration by decomposers
- reduction in dissolved oxygen
- death of organisms requiring dissolved oxygen in water

20.4 Conservation

Core	Supplement
1 Describe a sustainable resource as one which is produced as rapidly as it is removed from the environment so that it does not run out	
2 State that some resources can be conserved and managed sustainably, limited to forests and fish stocks	5 Explain how forests can be conserved using: education, protected areas, quotas and replanting 6 Explain how fish stocks can be conserved using: education, closed seasons, protected areas, controlled net types and mesh size, quotas and monitoring
3 Explain why organisms become endangered or extinct, including: climate change, habitat destruction, hunting, overharvesting, pollution and introduced species	
4 Describe how endangered species can be conserved, limited to: (a) monitoring and protecting species and habitats (b) education (c) captive breeding programmes (d) seed banks	7 Describe the reasons for conservation programmes, limited to: (a) maintaining or increasing biodiversity (b) reducing extinction (c) protecting vulnerable ecosystems (d) maintaining ecosystem functions, limited to nutrient cycling and resource provision, including food, drugs, fuel and genes 8 Describe the use of artificial insemination (AI) and *in vitro* fertilisation (IVF) in captive breeding programmes 9 Explain the risks to a species if its population size decreases, reducing genetic variation (knowledge of genetic drift is **not** required)

21 Biotechnology and genetic modification

21.1 Biotechnology and genetic modification

Core	Supplement
1 State that bacteria are useful in biotechnology and genetic modification due to their rapid reproduction rate and their ability to make complex molecules	2 Discuss why bacteria are useful in biotechnology and genetic modification, limited to: (a) few ethical concerns over their manipulation and growth (b) the presence of plasmids

21.2 Biotechnology

Core

1 Describe the role of anaerobic respiration in yeast during the production of ethanol for biofuels

2 Describe the role of anaerobic respiration in yeast during bread-making

3 Describe the use of pectinase in fruit juice production

4 Investigate and describe the use of biological washing powders that contain enzymes

Supplement

5 Explain the use of lactase to produce lactose-free milk

6 Describe how fermenters can be used for the large-scale production of useful products by bacteria and fungi, including insulin, penicillin and mycoprotein

7 Describe and explain the conditions that need to be controlled in a fermenter, including: temperature, pH, oxygen, nutrient supply and waste products

21.3 Genetic modification

Core

1 Describe genetic modification as changing the genetic material of an organism by removing, changing or inserting individual genes

Supplement

3 Outline the process of genetic modification using bacterial production of a human protein as an example, limited to:

(a) isolation of the DNA making up a human gene using restriction enzymes, forming sticky ends

(b) cutting of bacterial plasmid DNA with the same restriction enzymes, forming complementary sticky ends

(c) insertion of human DNA into bacterial plasmid DNA using DNA ligase to form a recombinant plasmid

(d) insertion of recombinant plasmids into bacteria (specific details are **not** required)

(e) multiplication of bacteria containing recombinant plasmids

(f) expression in bacteria of the human gene to make the human protein

continued

21.3 Genetic modification continued

Core	Supplement
2 Outline examples of genetic modification: (a) the insertion of human genes into bacteria to produce human proteins (b) the insertion of genes into crop plants to confer resistance to herbicides (c) the insertion of genes into crop plants to confer resistance to insect pests (d) the insertion of genes into crop plants to improve nutritional qualities	4 Discuss the advantages and disadvantages of genetically modifying crops, including soya, maize and rice

4 Details of the assessment

All candidates take three papers.

Candidates who have studied the Core subject content, or who are expected to achieve a grade D or below should be entered for Paper 1, Paper 3 and either Paper 5 or Paper 6. These candidates will be eligible for grades C to G.

Candidates who have studied the Extended subject content (Core and Supplement), and who are expected to achieve a grade C or above should be entered for Paper 2, Paper 4 and either Paper 5 or Paper 6. These candidates will be eligible for grades A* to G.

Core assessment

Core candidates take the following papers. The questions are based on the Core subject content only.

Paper 1: Multiple Choice (Core)		Paper 3: Theory (Core)
45 minutes		1 hour 15 minutes
40 marks		80 marks
Forty compulsory multiple-choice items of the four-choice type.		Compulsory short-answer and structured questions
This paper tests assessment objectives AO1 and AO2	**AND**	This paper tests assessment objectives AO1 and AO2
This paper assesses grades C to G		This paper assesses grades C to G
Externally assessed		Externally assessed

Extended assessment

Extended candidates take the following papers. The questions are based on the Core and Supplement subject content.

Paper 2: Multiple Choice (Extended)		Paper 4: Theory (Extended)
45 minutes		1 hour 15 minutes
40 marks		80 marks
Forty compulsory multiple-choice items of the four-choice type.		Compulsory short-answer and structured questions
This paper tests assessment objectives AO1 and AO2	**AND**	This paper tests assessment objectives AO1 and AO2
This paper assesses grades A* to G		This paper assesses grades A* to G
Externally assessed		Externally assessed

Practical assessment

All candidates take one practical component from a choice of two:

Paper 5: Practical Test		Paper 6: Alternative to Practical
1 hour 15 minutes 40 marks This paper tests assessment objective AO3 This paper assesses grades A* to G Candidates will be required to do experiments in a laboratory as part of this test	**OR**	1 hour 40 marks This paper tests assessment objective AO3 This paper assesses grades A* to G Candidates will not be required to do experiments as part of this test

Questions in the practical papers are structured to assess performance across the full grade range.

The Practical Test and Alternative to Practical:

- require the same experimental skills to be developed and learned
- require an understanding of the same experimental contexts
- test the same assessment objective, AO3.

Candidates are expected to be familiar with and may be asked questions on the following experimental contexts:

- simple quantitative experiments, including the measurement of:
  - volumes of gases and liquids
  - masses
  - temperatures
  - times
  - lengths
- diffusion
- osmosis
- food tests
- rates of enzyme-catalysed reactions, including judging end-points, e.g. colour changes
- pH and the use of hydrogencarbonate indicator, litmus and universal indicator
- photosynthesis (rate and limiting factors)
- transpiration
- heart rate and breathing rate
- respiration
- tropic responses
- observation and dissection of seeds and flowers
- germination
- continuous and discontinuous variation
- use methods of sampling that are representative and avoid bias, e.g. consideration of sample size and simple random sampling
- observe, record and measure images of familiar and unfamiliar biological specimens
- make clear line drawings of biological specimens, calculating the magnification or actual size and adding labels as required
- use simple apparatus in situations where the method may not be familiar to the candidate.

Candidates may be required to do the following:

- **demonstrate knowledge of how to select and safely use techniques, apparatus and materials (including following a sequence of instructions where appropriate):**
  - identify apparatus from diagrams or descriptions
  - draw, complete or label diagrams of apparatus and biological specimens
  - use, or explain the use of, common techniques, apparatus and materials
  - select the most appropriate apparatus or method for the task and justify the choice made
  - describe food tests
  - describe how the pH of a solution or substance can be tested
  - describe and explain hazards and safety precautions
  - describe and explain techniques used to ensure the accuracy of observations and data

- **plan experiments and investigations:**
  - identify the independent variable and dependent variable
  - describe how and explain why variables should be kept constant
  - suggest an appropriate number and range of values for the independent variable
  - suggest the most appropriate apparatus or technique and justify the choice made
  - describe experimental procedures, including a suitable control experiment
  - identify risks and suggest safety precautions
  - describe how to record the results of an experiment
  - describe how to process the results of an experiment to form a conclusion or to evaluate a prediction
  - make reasoned predictions of expected results

- **make and record observations, measurements and estimates:**
  - take readings from apparatus (analogue and digital) or from diagrams of apparatus with appropriate precision
  - take sufficient observations or measurements, including repeats and replicates where appropriate
  - record qualitative observations from food and other tests
  - record observations and measurements systematically, for example in a suitable table, to an appropriate degree of precision and using appropriate units

- **interpret and evaluate experimental observations and data:**
  - process data, including for use in further calculations or for graph plotting, using a calculator as appropriate
  - present data graphically
  - analyse and interpret observations and data, including data presented graphically
  - use interpolation and extrapolation graphically to determine a gradient or intercept
  - form conclusions justified by reference to observations and data and with appropriate explanation
  - evaluate the quality of observations and data, identifying any anomalous results and taking appropriate action

- **evaluate methods and suggest possible improvements:**
  - evaluate experimental arrangements, methods and techniques, including the use of a control
  - identify sources of error
  - suggest possible improvements to the apparatus, experimental arrangements, methods and techniques.

Apparatus, materials and reagents

These lists give items candidates should be familiar with using, whether they are taking the Practical Test or the Alternative to Practical.

These items should be available for use in the Practical Test. These lists are not exhaustive and we may also require other items to be sourced for specific exams. The Confidential Instructions we send before the Practical Test will give the detailed requirements for the exam.

Every effort is made to limit the resources required by centres and so minimise the costs. Experiments will be designed around basic apparatus and materials which should be available in most school laboratories or are easily obtainable.

Hazard codes are used where relevant and in accordance with information provided by CLEAPSS **(www.cleapss.org.uk**). Candidates should be familiar with the meanings of these codes and terms but will **not** be assessed on them.

C corrosive
HH health hazard
F flammable
N hazardous to the aquatic environment
MH moderate hazard
T acutely toxic
O oxidising

The attention of centres is drawn to any local regulations relating to safety, first aid and disposal of chemicals. 'Hazard Data Sheets' should be available from your chemical supplier.

Candidates must be provided with appropriate safety equipment, such as suitable eye protection and gloves, during practical work.

The Confidential Instructions will indicate which hazard symbols are applicable for the materials required for each Practical Test exam.

Chemicals, reagents and indicators

The list below is not intended to be comprehensive but shows the types of chemicals, reagents and indicators that candidates should be familiar with.

- Benedict's solution
- biuret reagent
- carbohydrates (starch, glucose, sucrose), proteins, lipids
- DCPIP
- dilute acid
- dilute alkali
- distilled or deionised water
- enzymes (e.g. amylase, a protease, lipase)
- ethanol
- indicators (universal indicator solution, hydrogencarbonate indicator, litmus solution)
- hydrogen peroxide solution
- iodine in potassium iodide solution (iodine solution)
- limewater

- methylene blue dye
- petroleum jelly (Vaseline® or similar)
- sodium chloride
- sodium hydrogencarbonate (sodium bicarbonate)

Apparatus

Other materials may be required for examinations.

- balance to measure up to 500 g, with precision of at least 0.1 g
- beakers (various sizes, 100 cm^3, 250 cm^3)
- bungs to fit standard test-tubes and large test-tubes
- bungs with delivery tubes to fit standard test-tubes and large test-tubes
- filter funnels
- filter paper
- forceps
- glass rods
- hand lenses (at least ×6 magnification)
- lamps for photosynthesis experiments
- means of cutting biological materials (e.g. scalpels or sharp knives)
- means of writing on glassware (e.g. wax pencils or water-resistant markers)
- measuring cylinders (e.g. 10, 25 and 100 cm^3)
- mounted needles or seekers or long pins with large heads
- rulers, graduated in mm
- scissors
- partially permeable membrane (e.g. Visking® or dialysis tubing)
- Pasteur or dropping pipette
- Petri dishes
- spotting tiles
- stop-clocks, reading to 1 s or better
- syringes (various sizes, 1 cm^3, 5 cm^3, 10 cm^3)
- test-tubes – standard (125 mm × 15 mm) and large (150 mm × 25 mm)
- test-tube racks and test-tube holders
- thermometers, –10 °C to +110 °C, with 1 °C graduations
- wash bottles
- white tiles or other suitable cutting surfaces

Safety in the laboratory

Teachers should make sure they do not contravene any school, education authority or government regulation. Responsibility for safety matters rests with centres. Further information can be found from the following UK associations, publications and regulations.

Associations

CLEAPSS is an advisory service providing support in practical science and technology.
www.cleapss.org.uk

Publications

CLEAPSS Laboratory Handbook, updated 2015 (available to CLEAPSS members only)

CLEAPSS Hazcards, 2019 update of 2016 edition (available to CLEAPSS members only)

UK regulations

Control of Substances Hazardous to Health Regulations (COSHH) 2002 and subsequent amendment in 2004

www.legislation.gov.uk/uksi/2002/2677/contents/made

www.legislation.gov.uk/uksi/2004/3386/contents/made

A brief guide may be found at **www.hse.gov.uk/pubns/indg136.pdf**

Mathematical requirements

It is expected that these requirements will be covered as part of a mathematics curriculum at this level of study.

Calculators may be used in all parts of the exam.

Number

- add, subtract, multiply and divide
- use decimals, fractions, ratios and reciprocals
- calculate and use percentages and percentage change
- use standard form
- express answers to an appropriate or given number of significant figures
- express answers to an appropriate or given number of decimal places
- round answers appropriately

Algebra

- recognise and use direct and inverse proportion
- solve simple algebraic equations for any one term when the other terms are known
- substitute physical quantities into a formula

Geometry and measurements

- convert between units, including cm^3 and dm^3, mg, g and kg, µm, mm, cm and m
- understand the meaning of angle, curve, circle, radius, diameter, circumference, square, rectangle and diagonal
- recall and use equations for the area of a rectangle, the area of a triangle and the area of a circle
- recall and use equations for the volume of a rectangular block and the volume of a cylinder
- use a ruler
- make estimates of numbers, quantities and lengths
- understand surface area and use surface area : volume ratio
- use scale diagrams
- select and use the most appropriate units for recording data and the results of calculations

Graphs, charts and statistics

- draw charts and graphs from data
- interpret line graphs, bar charts, pie charts and histograms with equal intervals
- interpolate and extrapolate from data
- determine the gradient and intercept of a graph, including units where appropriate
- select suitable scales and axes for graphs
- recognise direct and inverse proportionality from a graph
- calculate the mean and range of a set of values
- use simple probability

Presentation of data

Taking and recording readings

- Data should be recorded so as to reflect the precision of the measuring instrument, i.e. the smallest difference that can reliably be detected on the measuring instrument scale should be reflected by the number of decimal places given in the measurement.
- A measurement or calculated quantity must be accompanied by a correct unit, where appropriate.
- Each column of a table should be headed with the observation or physical quantity and the unit where appropriate, e.g. time/s. The solidus (/) is to be used for separating the quantity and the unit in tables, graphs and charts.
- Units should not be included with data in the body of a table.
- Data should be recorded to the appropriate number of significant figures.

Graphs

- The column headings of a correctly headed table can be directly transferred to the axes of a constructed graph.
- A graph should be drawn with a sharp pencil.
- Each axis should be labelled with the observation or physical quantity and the unit where appropriate, e.g. time/s.
- Unless instructed otherwise, the independent variable should be plotted on the *x*-axis (horizontal axis) and the dependent variable plotted on the *y*-axis (vertical axis).

- Unless instructed otherwise, the scales for the axes should allow more than half of the graph grid to be used in both directions, and be based on sensible ratios, e.g. 2 cm on the graph grid representing 1, 2 or 5 units of the variable. The axes do not have to include (0, 0).
- Points on the graph should be clearly marked as crosses (×) or encircled dots (⊙) of appropriate size.
- Each data point should be plotted to an accuracy of one half of one of the smallest squares on the grid.
- A best-fit line (trend line) should be a single, thin, smooth straight line or curve. The line does not need to coincide exactly with any of the points; where there is scatter evident in the data, examiners would expect a roughly even distribution of points either side of the line over its entire length. Points that are clearly anomalous should be ignored when drawing the best-fit line.
- A best-fit line or curve should only be drawn if there is good reason to believe that the intermediate values can be predicted.
- Candidates should be able to take readings from the graph by extrapolation or interpolation and indicate on the graph how they determined the reading.
- Data values should be read from a graph to an accuracy of one half of the smallest square on the grid.

Drawings

- Drawings should be drawn using a sharp pencil to give fine lines that are clear and unbroken.
- Drawings should use most of the available space and show all the features observed in the specimen, with no shading or use of colour.
- Label lines should be drawn with a ruler and touch the object or feature labelled.

Charts

- Pie charts are generally used to show percentage or proportionality.
- Bar charts should be drawn for categorical or discrete data. They should be made up of bars of equal width that do **not** touch.
- Histograms should be drawn for continuous data. They should have bars that touch.

Further guidance can be found in the following publications:

ASE, The Language of Mathematics in Science: A Guide for Teachers of 11–16 Science (2016).

ASE, The Language of Mathematics in Science: Teaching Approaches (2016).

www.ase.org.uk/mathsinscience

Conventions (e.g. signs, symbols, terminology and nomenclature)

Candidates are expected to be familiar with the nomenclature used in the syllabus.

The syllabus and question papers conform with accepted international practice. In particular, the following document, produced by the Association for Science Education (ASE), should be used as a guideline.

Signs, Symbols and Systematics: The ASE Companion to 16–19 Science (2000).

Decimal markers

In accordance with current ASE convention, decimal markers in examination papers will be a single dot on the line. Candidates are expected to follow this convention in their answers.

Numbers

Numbers from 1000 to 9999 will be printed without commas or spaces. Numbers greater than or equal to 10 000 will be printed without commas. A space will be left between each group of three digits, e.g. 4 256 789.

Variables

Independent variables are the variables that are changed in a scientific experiment by the scientist. Changing an independent variable may cause a change in the dependent variable.

Dependent variables are the variables that are observed or measured in a scientific experiment. Dependent variables may change based on changes made to the independent variables.

Units

To avoid any confusion concerning the symbol for litre, the equivalent quantity, the cubic decimetre (dm^3) will be used in place of l or litre.

In practical work, candidates will be expected to use SI units or, where appropriate, units approved for use with the SI (e.g. minute).

In all examinations, where data is supplied for use in questions, candidates will be expected to use units that are consistent with the units supplied and should not attempt conversion to other systems of units unless this is a requirement of the question.

Command words

Command words and their meanings help candidates know what is expected from them in the exams. The table below includes command words used in the assessment for this syllabus. The use of the command word will relate to the subject context.

Command word	What it means
Calculate	work out from given facts, figures or information
Compare	identify/comment on similarities and/or differences
Define	give precise meaning
Describe	state the points of a topic / give characteristics and main features
Determine	establish an answer using the information available
Evaluate	judge or calculate the quality, importance, amount, or value of something
Explain	set out purposes or reasons / make the relationships between things clear / say why and/or how and support with relevant evidence
Give	produce an answer from a given source or recall/memory
Identify	name/select/recognise
Outline	set out the main points
Predict	suggest what may happen based on available information
Sketch	make a simple freehand drawing showing the key features, taking care over proportions
State	express in clear terms
Suggest	apply knowledge and understanding to situations where there are a range of valid responses in order to make proposals / put forward considerations

5 What else you need to know

This section is an overview of other information you need to know about this syllabus. It will help to share the administrative information with your exams officer so they know when you will need their support. Find more information about our administrative processes at **www.cambridgeinternational.org/eoguide**

Before you start

Previous study

We recommend that learners starting this course should have studied a broad curriculum such as the Cambridge Lower Secondary programme or equivalent national educational framework.

Guided learning hours

We design Cambridge IGCSE syllabuses to require about 130 guided learning hours for each subject. This is for guidance only. The number of hours a learner needs to achieve the qualification may vary according to each school and the learners' previous experience of the subject.

Availability and timetables

All Cambridge schools are allocated to one of six administrative zones. Each zone has a specific timetable. Find your administrative zone at **www.cambridginternational.org/adminzone**

You can view the timetable for your administrative zone at **www.cambridgeinternational.org/timetables**

You can enter candidates in the June and November exam series. If your school is in India, you can also enter your candidates in the March exam series.

Check you are using the syllabus for the year the candidate is taking the exam.

Private candidates can enter for this syllabus. For more information, please refer to the *Cambridge Guide to Making Entries*.

Combining with other syllabuses

Candidates can take this syllabus alongside other Cambridge International syllabuses in a single exam series. The only exceptions are:

- Cambridge O Level Biology (5090)
- Cambridge IGCSE (9–1) Biology (0970)
- Cambridge IGCSE Combined Science (0653)
- Cambridge IGCSE Co-ordinated Sciences (Double Award) (0654)
- Cambridge IGCSE (9–1) Co-ordinated Sciences (Double Award) (0973)
- Cambridge O Level Combined Science (5129)
- syllabuses with the same title at the same level.

Cambridge IGCSE, Cambridge IGCSE (9–1) and Cambridge O Level syllabuses are at the same level.

Group awards: Cambridge ICE

Cambridge ICE (International Certificate of Education) is a group award for Cambridge IGCSE. It encourages schools to offer a broad and balanced curriculum by recognising the achievements of learners who pass exams in a range of different subjects.

Learn more about Cambridge ICE at **www.cambridgeinternational.org/cambridgeice**

Making entries

Exams officers are responsible for submitting entries to Cambridge International. We encourage them to work closely with you to make sure they enter the right number of candidates for the right combination of syllabus components. Entry option codes and instructions for submitting entries are in the *Cambridge Guide to Making Entries*. Your exams officer has access to this guide.

Exam administration

To keep our exams secure, we produce question papers for different areas of the world, known as administrative zones. We allocate all Cambridge schools to an administrative zone determined by their location. Each zone has a specific timetable.

Some of our syllabuses offer candidates different assessment options. An entry option code is used to identify the components the candidate will take relevant to the administrative zone and the available assessment options.

Support for exams officers

We know how important exams officers are to the successful running of exams. We provide them with the support they need to make entries on time. Your exams officer will find this support, and guidance for all other phases of the Cambridge Exams Cycle, at **www.cambridgeinternational.org/eoguide**

Retakes

Candidates can retake the whole qualification as many times as they want to. Information on retake entries is at **www.cambridgeinternational.org/retakes**

Language

This syllabus and the related assessment materials are available in English only.

Accessibility and equality

Syllabus and assessment design

At Cambridge International, we work to avoid direct or indirect discrimination in our syllabuses and assessment materials. We aim to maximise inclusivity for candidates of all national, cultural or social backgrounds and candidates with protected characteristics, which include special educational needs and disability, religion and belief, and characteristics related to gender and identity. We also aim to make our materials as accessible as possible by using accessible language and applying accessible design principles. This gives all candidates the fairest possible opportunity to demonstrate their knowledge, skills and understanding and helps to minimise the requirement to make reasonable adjustments during the assessment process.

Access arrangements

Access arrangements (including modified papers) are the principal way in which Cambridge International complies with our duty, as guided by the UK Equality Act (2010), to make 'reasonable adjustments' for candidates with special educational needs (SEN), disability, illness or injury. Where a candidate would otherwise be at a substantial disadvantage in comparison to a candidate with no SEN, disability, illness or injury, we may be able to agree pre-examination access arrangements. These arrangements help a candidate by minimising accessibility barriers and maximising their opportunity to demonstrate their knowledge, skills and understanding in an assessment.

Important:

Requested access arrangements should be based on evidence of the candidate's barrier to assessment and should also reflect their normal way of working at school. This is explained in the *Cambridge Handbook* **www.cambridgeinternational.org/eoguide**

- For Cambridge International to approve an access arrangement, we will need to agree that it constitutes a reasonable adjustment, involves reasonable cost and timeframe and does not affect the security and integrity of the assessment.
- Availability of access arrangements should be checked by centres at the start of the course. Details of our standard access arrangements and modified question papers are available in the *Cambridge Handbook* **www.cambridgeinternational.org/eoguide**
- Please contact us at the start of the course to find out if we are able to approve an arrangement that is not included in the list of standard access arrangements.
- Candidates who cannot access parts of the assessment may be able to receive an award based on the parts they have completed.

After the exam

Grading and reporting

Grades A*, A, B, C, D, E, F or G indicate the standard a candidate achieved at Cambridge IGCSE.

A* is the highest and G is the lowest. 'Ungraded' means that the candidate's performance did not meet the standard required for grade G. 'Ungraded' is reported on the statement of results but not on the certificate.

In specific circumstances your candidates may see one of the following letters on their statement of results:

- Q (PENDING)
- X (NO RESULT).

These letters do not appear on the certificate.

On the statement of results and certificates, Cambridge IGCSE is shown as INTERNATIONAL GENERAL CERTIFICATE OF SECONDARY EDUCATION (IGCSE).

How students and teachers can use the grades

Assessment at Cambridge IGCSE has two purposes:

1 to measure learning and achievement

The assessment confirms achievement and performance in relation to the knowledge, understanding and skills specified in the syllabus.

2 to show likely future success

The outcomes help predict which students are well prepared for a particular course or career and/or which students are more likely to be successful.

The outcomes help students choose the most suitable course or career.

Changes to this syllabus for 2026, 2027 and 2028

The syllabus has been updated. This is version 1, published September 2023.

There are no significant changes which affect teaching.

You must read the whole syllabus before planning your teaching programme. We review our syllabuses regularly to make sure they continue to meet the needs of our schools. In updating this syllabus, we have made it easier for teachers and students to understand, keeping the familiar features that teachers and schools value.

Any textbooks endorsed to support the syllabus for examination from 2023 are still suitable for use with this syllabus.

School feedback: ‘While studying Cambridge IGCSE and Cambridge International A Levels, students broaden their horizons through a global perspective and develop a lasting passion for learning.’

Feedback from: Zhai Xiaoning, Deputy Principal, The High School Affiliated to Renmin University of China

We are committed to making our documents accessible in accordance with the WCAG 2.1 Standard. We are always looking to improve the accessibility of our documents. If you find any problems or you think we are not meeting accessibility requirements, contact us at **info@cambridgeinternational.org** with the subject heading: Digital accessibility. If you need this document in a different format, contact us and supply your name, email address and requirements and we will respond within 15 working days.

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