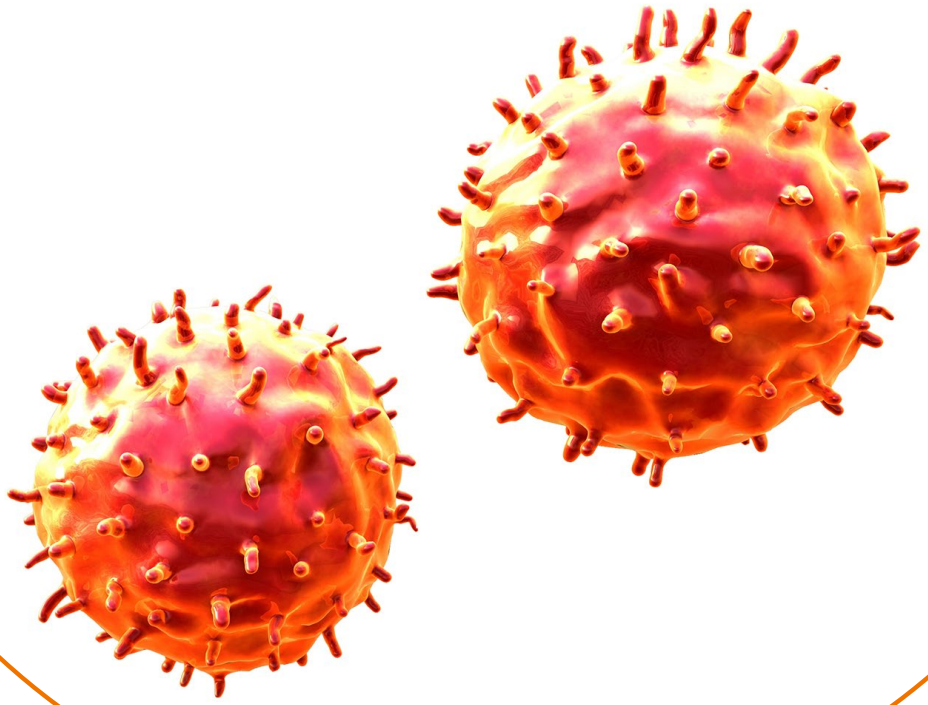
Cambridge Assessment International Education

Syllabus

Cambridge IGCSE® (9–1) Biology 0970

For centres in the UK

For examination in June and November 2020 and 2021.



Version 1

Please check the syllabus page at **www.cambridgeinternational.org/igcse** to see if this syllabus is available in your administrative zone.

Cambridge Pathway

Why choose Cambridge?

Cambridge Assessment International Education 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 international qualifications are recognised by the world's best universities and employers, giving students a wide range of options in their education and career. As a not-for-profit organisation, we devote our resources to delivering high-quality educational programmes that can unlock learners' potential.

Our programmes and qualifications set the global standard for international education. They are created by subject experts, 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.

Our mission is to provide educational benefit through provision of international programmes and qualifications for school education and to be the world leader in this field. 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 an international education from Cambridge International.

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

Christoph Guttentag, Dean of Undergraduate Admissions, Duke University, USA

Quality management

Our systems for managing the provision of international qualifications and education programmes for students aged 5 to 19 are certified as meeting the internationally recognised standard for quality management, ISO 9001:2008. Learn more at **www.cambridgeinternational.org/ISO9001**

Contents

Changes to this syllabus

For information about changes to this syllabus for 2020 and 2021, go to page 58.

The latest syllabus is version 1, published September 2017. There are no significant changes which affect teaching.

Any textbooks endorsed to support IGCSE Biology (0610) for examination from 2016 are suitable for use with this syllabus.

1 Why choose this syllabus?

Key benefits

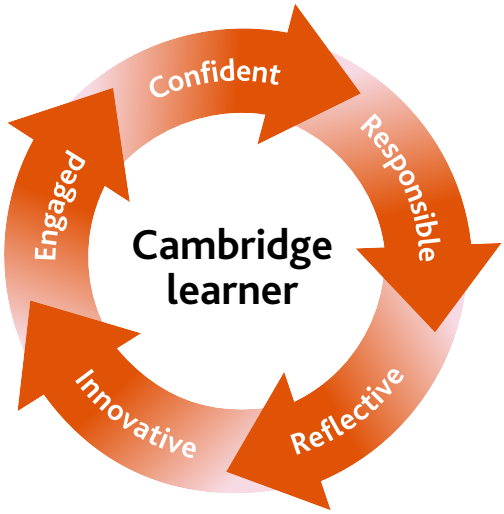
Cambridge IGCSE® syllabuses are created especially for international students. For over 25 years, we have worked with schools and teachers worldwide to develop syllabuses that are suitable for different countries, different types of schools and for learners with a wide range of abilities.

Cambridge IGCSE (9–1) Biology enables learners to:

- increase their understanding of the technological world
- take an informed interest in scientific matters
- recognise the usefulness (and limitations) of scientific method, and how to apply this to other disciplines and in everyday life
- develop relevant attitudes, such as a concern for accuracy and precision, objectivity, integrity, enquiry, initiative and inventiveness
- develop an interest in, and care for, the environment
- better understand the influences and limitations placed on scientific study by society, economy, technology, ethics, the community and the environment
- develop an understanding of the scientific skills essential for both further study and everyday life.

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

Our approach encourages learners to be:



'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.'

Gary Tan, Head of Schools and CEO, Raffles International Group of Schools, Indonesia

Recognition and progression

The combination of knowledge and skills in Cambridge IGCSE (9–1) Biology gives learners a solid foundation for further study. Candidates who achieve grades 4 to 9 are well prepared to follow a wide range of courses including Cambridge International AS & A Level Biology.

Cambridge IGCSEs are accepted and valued by leading universities and employers around the world as evidence of academic achievement. Many universities require a combination of Cambridge International AS & A Levels and Cambridge IGCSEs or equivalent to meet their entry requirements.

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

'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.'

Mrs Omnia Kassabgy, Managing Director of British School in Egypt BSE

Supporting teachers

We provide a wide range of practical resources, detailed guidance, and innovative training and professional development so that you can give your learners the best possible preparation for Cambridge IGCSE.

Support for Cambridge IGCSE

Teaching resources

- School Support Hub
  www.cambridgeinternational.org/support
- Syllabus
- Scheme of work
- Learner guide
- Discussion forum
- Resource list
- Endorsed textbooks and digital resources

Exam preparation resources

- Question papers
- Mark schemes
- Example candidate responses to understand what examiners are looking for at key grades
- Examiner reports to improve future teaching

Training

- Face-to-face workshops around the world
- Online self-study training
- Online tutor-led training
- Cambridge Professional Development Qualifications

Community

You can find useful information, as well as share your ideas and experiences with other teachers, on our social media channels and community forums.

Find out more at
www.cambridgeinternational.org/social-media

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:

- provide an enjoyable and worthwhile educational experience for all learners, whether or not they go on to study science beyond this level
- enable learners to acquire sufficient knowledge and understanding to:
  - become confident citizens in a technological world and develop an informed interest in scientific matters
  - be suitably prepared for studies beyond Cambridge IGCSE
- allow learners to recognise that science is evidence based and understand the usefulness, and the limitations, of scientific method
- develop skills that:
  - are relevant to the study and practice of biology
  - are useful in everyday life
  - encourage a systematic approach to problem solving
  - encourage efficient and safe practice
  - encourage effective communication through the language of science
- develop attitudes relevant to biology such as:
  - concern for accuracy and precision
  - objectivity
  - integrity
  - enquiry
  - initiative
  - inventiveness
- enable learners to appreciate that:
  - science is subject to social, economic, technological, ethical and cultural influences and limitations
  - the applications of science may be both beneficial and detrimental to the individual, the community and the environment.

Content overview

Candidates study the following topics:

1 Characteristics and classification of living organisms
2 Organisation of the organism
3 Movement in 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 Biotechnology and genetic engineering
21 Human influences on ecosystems

Support for Cambridge IGCSE (9–1) Biology

Our School Support Hub **www.cambridgeinternational.org/support** provides Cambridge schools with a secure site for downloading specimen and past question papers, mark schemes, grade thresholds and other curriculum resources specific to this syllabus. The School Support Hub community offers teachers the opportunity to connect with each other and to ask questions related to the syllabus.

Assessment overview

All candidates take three papers.

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

Candidates who have studied the Extended subject content (Core and Supplement), and who are expected to achieve a grade 4 or above, should be entered for Paper 2, Paper 4 and either Paper 5 or Paper 6. These candidates will be eligible for grades 1 to 9.

Core candidates take:

Paper 1 45 minutes
Multiple Choice 30%

40 marks

40 four-choice multiple-choice questions

Questions will be based on the Core subject content

Assessing grades 1–5

Externally assessed

Extended candidates take:

Paper 2 45 minutes
Multiple Choice 30%

40 marks

40 four-choice multiple-choice questions

Questions will be based on the Extended subject content (Core and Supplement)

Assessing grades 1–9

Externally assessed

and Core candidates take:

Paper 3 1 hour 15 minutes
Theory 50%

80 marks

Short-answer and structured questions

Questions will be based on the Core subject content

Assessing grades 1–5

Externally assessed

and Extended candidates take:

Paper 4 1 hour 15 minutes
Theory 50%

80 marks

Short-answer and structured questions

Questions will be based on the Extended subject content (Core and Supplement)

Assessing grades 1–9

Externally assessed

All candidates take either:

Paper 5 1 hour 15 minutes
Practical Test 20%

40 marks

Questions will be based on the experimental skills in Section 4

Assessing grades 1–9

Externally assessed

or:

Paper 6 1 hour
Alternative to Practical 20%

40 marks

Questions will be based on the experimental skills in Section 4

Assessing grades 1–9

Externally assessed

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 that require them to apply this material to unfamiliar contexts and to apply knowledge from one area of the syllabus to another.

Questions testing this objective will often begin with one of the following words: *define*, *state*, *describe*, *explain* (*using your knowledge and understanding*) or *outline* (see the *Glossary of terms used in science papers*).

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 draw inferences
- present reasoned explanations for phenomena, patterns and relationships
- make predictions and hypotheses
- 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.

Questions testing these skills will often begin with one of the following words: *predict*, *suggest*, *calculate* or *determine* (see the *Glossary of terms used in science papers*).

AO3 Experimental skills and investigations

Candidates should be able to:

- demonstrate knowledge of how to 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

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

3 Subject content

All candidates should be taught the Core subject content. Candidates who are only taught the Core subject content can achieve a maximum of grade 5. Candidates aiming for grades 4 to 9 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 practical skills by carrying out practical work and investigations within all of the topics listed.

1 Characteristics and classification of living organisms

1.1 Characteristics of living organisms

Core	Supplement
• Describe the characteristics of living organisms by defining the terms:	• Define the terms:
– *movement* as an action by an organism causing a change of position or place	– *movement* as an action by an organism or part of an organism causing a change of position or place
– *respiration* as the chemical reactions in cells that break down nutrient molecules and release energy	– *respiration* as the chemical reactions in cells that break down nutrient molecules and release energy for metabolism
– *sensitivity* as the ability to detect and respond to changes in the environment	– *sensitivity* as the ability to detect or sense stimuli in the internal or external environment and to make appropriate responses
– *growth* as a permanent increase in size	– *growth* as a permanent increase in size and dry mass by an increase in cell number or cell size or both
– *reproduction* as the processes that make more of the same kind of organism	
– *excretion* as removal from organisms of toxic materials and substances in excess of requirements	– *excretion* as removal from organisms of the waste products of metabolism (chemical reactions in cells including respiration), toxic materials, and substances in excess of requirements
– *nutrition* as taking in of materials for energy, growth and development	– *nutrition* as taking in of materials for energy, growth and development; plants require light, carbon dioxide, water and ions; animals need organic compounds and ions and usually need water

1.2 Concept and use of a classification system

Core

- State that organisms can be classified into groups by the features that they share
- Define *species* as a group of organisms that can reproduce to produce fertile offspring
- Define and 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

Supplement

- Explain that classification systems aim to reflect evolutionary relationships
- Explain that classification is traditionally based on studies of morphology and anatomy
- Explain that the sequences of bases in DNA and of amino acids in proteins are used as a more accurate means of classification
- Explain that 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

- List the features in the cells of all living organisms, limited to cytoplasm, cell membrane and DNA as genetic material
- List the main features used to place animals and plants into the appropriate kingdoms
- List the main features used to place organisms into groups within the animal kingdom, limited to:
  - the main groups of vertebrates: mammals, birds, reptiles, amphibians, fish
  - the main groups of arthropods: myriapods, insects, arachnids, crustaceans

Supplement

- List the features in the cells of all living organisms, limited to ribosomes for protein synthesis and enzymes involved in respiration
- List the main features used to place all organisms into one of the five kingdoms: Animal, Plant, Fungus, Prokaryote, Protoctist
- List the main features used to place organisms into groups within the plant kingdom, limited to ferns and flowering plants (dicotyledons and monocotyledons)
- List the features of viruses, limited to protein coat and genetic material

1.4 Dichotomous keys

Core

- Construct and use simple dichotomous keys based on easily identifiable features

2 Organisation of the organism

2.1 Cell structure and organisation

Core

- Describe and compare the structure of a plant cell with an animal cell, as seen under a light microscope, limited to cell wall, nucleus, cytoplasm, chloroplasts, vacuoles and location of the cell membrane
- State the functions of the structures seen under the light microscope in the plant cell and in the animal cell

Supplement

- State that the cytoplasm of all cells contains structures, limited to ribosomes on rough endoplasmic reticulum and vesicles
- State that almost all cells, except prokaryotes, have mitochondria and rough endoplasmic reticulum
- Identify mitochondria and rough endoplasmic reticulum in diagrams and images of cells
- State that aerobic respiration occurs in mitochondria
- State that cells with high rates of metabolism require large numbers of mitochondria to provide sufficient energy

2.2 Levels of organisation

Core

- Relate the structure of the following to their functions:
  - ciliated cells – movement of mucus in the trachea and bronchi
  - root hair cells – absorption
  - xylem vessels – conduction and support
  - palisade mesophyll cells – photosynthesis
  - nerve cells – conduction of impulses
  - red blood cells – transport of oxygen
  - sperm and egg cells – reproduction
- Define *tissue* as a group of cells with similar structures, working together to perform a shared function
- Define *organ* as a structure made up of a group of tissues, working together to perform specific functions
- Define *organ system* as a group of organs with related functions, working together to perform body functions
- State examples of tissues, organs and organ systems from sections 6 to 16
- Identify the different levels of organisation in drawings, diagrams and images of familiar material

Supplement

- Identify the different levels of organisation in drawings, diagrams and images of unfamiliar material

2.3 Size of specimens

Core	Supplement
• Calculate magnification and size of biological specimens using millimetres as units	• Calculate magnification and size of biological specimens using millimetres and micrometres as units

3 Movement in and out of cells

3.1 Diffusion

Core	Supplement
• Define *diffusion* as the net movement of particles from a region of their higher concentration to a region of their lower concentration down a concentration gradient, as a result of their random movement	• State that the energy for diffusion comes from the kinetic energy of random movement of molecules and ions
• Describe the importance of diffusion of gases and solutes	
• State that substances move into and out of cells by diffusion through the cell membrane	
	• Investigate the factors that influence diffusion, limited to surface area, temperature, concentration gradients and distance

3.2 Osmosis

Core	Supplement
• State that water diffuses through partially permeable membranes by osmosis	• Define *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
• State that water moves in and out of cells by osmosis through the cell membrane	
• Investigate and describe the effects on plant tissues of immersing them in solutions of different concentrations	• Explain the effects on plant tissues of immersing them in solutions of different concentrations by using the terms *turgid*, *turgor pressure*, *plasmolysis* and *flaccid*
	• Explain the importance of water potential and osmosis in the uptake of water by plants
	• Explain the importance of water potential and osmosis on animal cells and tissues
• State that plants are supported by the pressure of water inside the cells pressing outwards on the cell wall	• Explain how plants are supported by the turgor pressure within cells, in terms of water pressure acting against an inelastic cell wall

3.3 Active transport

Core	Supplement
• Define *active transport* as the movement of particles through a cell membrane from a region of lower concentration to a region of higher concentration using energy from respiration	• Discuss the importance of active transport as a process for movement across membranes: – e.g. ion uptake by root hairs and uptake of glucose by epithelial cells of villi and kidney tubules • Explain how protein molecules move particles across a membrane during active transport

4 Biological molecules

4.1 Biological molecules

Core	Supplement
• List the chemical elements that make up: – carbohydrates – fats – proteins • State that large molecules are made from smaller molecules, limited to: – starch and glycogen from glucose – cellulose from glucose – proteins from amino acids – fats and oils from fatty acids and glycerol • Describe the use of: – iodine solution to test for starch – Benedict's solution to test for reducing sugars – biuret test for proteins – ethanol emulsion test for fats and oils – DCPIP test for vitamin C	• Explain that different sequences of amino acids give different shapes to protein molecules • Relate the shape and structure of protein molecules to their function, limited to the active site of enzymes and the binding site of antibodies

continued

4.1 Biological molecules continued

Core	Supplement
	• Describe the structure of DNA as: – two strands coiled together to form a double helix – each strand contains chemicals called bases – cross-links between the strands are formed by pairs of bases – the bases always pair up in the same way: A with T, and C with G (full names are **not** required)
• State that water is important as a solvent	• Describe the roles of water as a solvent in organisms with respect to digestion, excretion and transport

5 Enzymes

5.1 Enzymes

Core	Supplement
• Define the term *catalyst* as a substance that increases the rate of a chemical reaction and is not changed by the reaction	
• Define *enzymes* as proteins that function as biological catalysts	
• Describe why enzymes are important in all living organisms in terms of reaction speed necessary to sustain life	
• Describe enzyme action with reference to the complementary shape of an enzyme and its substrate and the formation of a product (knowledge of the term *active site* is **not** required)	• Explain enzyme action with reference to the active site, enzyme-substrate complex, substrate and product • Explain the specificity of enzymes in terms of the complementary shape and fit of the active site with the substrate
• Investigate and describe the effect of changes in temperature and pH on enzyme activity	• Explain the effect of changes in temperature on enzyme activity in terms of kinetic energy, shape and fit, frequency of effective collisions and denaturation • 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
• Define *photosynthesis* as the process by which plants manufacture carbohydrates from raw materials using energy from light	
• State the word equation for photosynthesis: carbon dioxide + water → glucose + oxygen, in the presence of light and chlorophyll	• State the balanced chemical equation for photosynthesis $6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{light}} C_6H_{12}O_6 + 6O_2$
	• Explain that chlorophyll transfers light energy into chemical energy in molecules, for the synthesis of carbohydrates • Outline the subsequent use and storage of the carbohydrates made in photosynthesis
• Investigate the necessity for chlorophyll, light and carbon dioxide for photosynthesis, using appropriate controls • Investigate and describe the effects of varying light intensity, carbon dioxide concentration and temperature on the rate of photosynthesis, e.g. in submerged aquatic plants	
	• Define the term *limiting factor* as something present in the environment in such short supply that it restricts life processes • Identify and explain the limiting factors of photosynthesis in different environmental conditions • Describe the use of carbon dioxide enrichment, optimum light and optimum temperatures in glasshouses in temperate and tropical countries • Use hydrogencarbonate indicator solution to investigate the effect of gas exchange of an aquatic plant kept in the light and in the dark

6.2 Leaf structure

Core	Supplement
• Identify chloroplasts, cuticle, guard cells and stomata, upper and lower epidermis, palisade mesophyll, spongy mesophyll, vascular bundles, xylem and phloem in leaves of a dicotyledonous plant	• Explain how the internal structure of a leaf is adapted for photosynthesis

6.3 Mineral requirements

Core

- Describe the importance of:
  - nitrate ions for making amino acids
  - magnesium ions for making chlorophyll

Supplement

- Explain the effects of nitrate ion and magnesium ion deficiency on plant growth

7 Human nutrition

7.1 Diet

Core

- State what is meant by the term *balanced diet* for humans
- Explain how age, gender and activity affect the dietary needs of humans including during pregnancy and whilst breast-feeding
- Describe the effects of malnutrition in relation to starvation, constipation, coronary heart disease, obesity and scurvy
- List the principal sources of, and describe the dietary importance of:
  - carbohydrates
  - fats
  - proteins
  - vitamins, limited to C and D
  - mineral salts, limited to calcium and iron
  - fibre (roughage)
  - water

Supplement

- Explain the causes and effects of vitamin D and iron deficiencies
- Explain the causes and effects of protein-energy malnutrition, e.g. kwashiorkor and marasmus

7.2 Alimentary canal

Core	Supplement
• Define *ingestion* as the taking of substances, e.g. food and drink, into the body through the mouth	
• Define *mechanical digestion* as the breakdown of food into smaller pieces without chemical change to the food molecules	
• Define *chemical digestion* as the breakdown of large, insoluble molecules into small, soluble molecules	
• Define *absorption* as the movement of small food molecules and ions through the wall of the intestine into the blood	
• Define *assimilation* as the movement of digested food molecules into the cells of the body where they are used, becoming part of the cells	
• Define *egestion* as the passing out of food that has not been digested or absorbed, as faeces, through the anus	
• Describe diarrhoea as the loss of watery faeces	
• Outline the treatment of diarrhoea using oral rehydration therapy	
• Describe cholera as a disease caused by a bacterium	• 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 salts from blood
• Identify the main regions of the alimentary canal and associated organs, limited to mouth, salivary glands, oesophagus, stomach, small intestine (duodenum and ileum), pancreas, liver, gall bladder and large intestine (colon, rectum, anus)	
• Describe the functions of the regions of the alimentary canal listed above, in relation to ingestion, digestion, absorption, assimilation and egestion of food	

7.3 Mechanical digestion

Core

- Identify the types of human teeth (incisors, canines, premolars and molars)
- Describe the structure of human teeth, limited to enamel, dentine, pulp, nerves and cement, as well as the gums
- Describe the functions of the types of human teeth in mechanical digestion of food
- State the causes of dental decay in terms of a coating of bacteria and food on teeth, the bacteria respiring sugars in the food, producing acid which dissolves the enamel and dentine
- Describe the proper care of teeth in terms of diet and regular brushing

7.4 Chemical digestion

Core

- State the significance of chemical digestion in the alimentary canal in producing small, soluble molecules that can be absorbed
- State the functions of enzymes as follows:
  - amylase breaks down starch to simpler sugars
  - protease breaks down protein to amino acids
  - lipase breaks down fats to fatty acids and glycerol
- State where, in the alimentary canal, amylase, protease and lipase are secreted
- State the functions of the hydrochloric acid in gastric juice, limited to killing bacteria in food and giving an acid pH for enzymes

Supplement

- Describe the digestion of starch in the alimentary canal:
  - amylase is secreted into the alimentary canal and breaks down starch to maltose
  - maltose is broken down by maltase to glucose on the membranes of the epithelium lining the small intestine
- Describe pepsin and trypsin as two protease enzymes that function in different parts of the alimentary canal:
  - pepsin in the stomach
  - trypsin in the small intestine
- Explain the functions of the hydrochloric acid in gastric juice, limited to the low pH:
  - denaturing enzymes in harmful microorganisms in food
  - giving the optimum pH for pepsin activity
- Outline the role of bile in neutralising the acidic mixture of food and gastric juices entering the duodenum from the stomach, to provide a suitable pH for enzyme action
- Outline the role of bile in emulsifying fats to increase the surface area for the chemical digestion of fat to fatty acids and glycerol by lipase

7.5 Absorption

Core

- Identify the small intestine as the region for the absorption of digested food
- State that water is absorbed in both the small intestine and the colon, but that most absorption of water happens in the small intestine

Supplement

- Explain the significance of villi and microvilli in increasing the internal surface area of the small intestine
- Describe the structure of a villus
- Describe the roles of capillaries and lacteals in villi

8 Transport in plants

8.1 Transport in plants

Core

- State the functions of xylem and phloem
- Identify the position of xylem and phloem as seen in sections of roots, stems and leaves, limited to non-woody dicotyledonous plants

8.2 Water uptake

Core

- Identify root hair cells, as seen under the light microscope, and state their functions
- State the pathway taken by water through root, stem and leaf as root hair cell, root cortex cells, xylem and mesophyll cells
- Investigate, using a suitable stain, the pathway of water through the above-ground parts of a plant

Supplement

- Explain that the large surface area of root hairs increases the rate of the absorption of water by osmosis and ions by active transport

8.3 Transpiration

Core	Supplement
• State that water is transported from the roots to leaves through the xylem vessels	
• Define *transpiration* as loss of water vapour from plant leaves by evaporation of water at the surfaces of the mesophyll cells followed by diffusion of water vapour through the stomata	
	• Explain how water vapour loss is related to the large surface area of cell surfaces, interconnecting air spaces and stomata
	• 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 cohesion
	• Explain how and why wilting occurs
• Investigate and describe the effects of variation of temperature and humidity on transpiration rate	• Explain the effects of variation of temperature and humidity on transpiration rate

8.4 Translocation

	Supplement
	• Define *translocation* in terms of the movement of sucrose and amino acids in phloem: – from regions of production (source) – to regions of storage OR to regions where they are used in respiration or growth (sink)
	• Explain that some parts of a plant may act as a source and a sink at different times during the life of a plant

9 Transport in animals

9.1 Transport in animals

Core	Supplement
• Describe the circulatory system as a system of blood vessels with a pump and valves to ensure one-way flow of blood	• Describe the single circulation of a fish
	• Describe the double circulation of a mammal
	• Explain the advantages of a double circulation

9.2 Heart

Core

- Name and identify the structures of the mammalian heart, limited to the muscular wall, the septum, the left and right ventricles and atria, one-way valves and coronary arteries
- State that blood is pumped away from the heart into arteries and returns to the heart in veins
- State that the activity of the heart may be monitored by ECG, pulse rate and listening to sounds of valves closing
- Investigate and state the effect of physical activity on the pulse rate
- Describe coronary heart disease in terms of the blockage of coronary arteries and state the possible risk factors as diet, stress, smoking, genetic predisposition, age and gender

Supplement

- Name and identify the atrioventricular and semilunar valves in the mammalian heart
- Explain the relative thickness:
  - of the muscle wall of the left and right ventricles
  - of the muscle wall of the atria compared to that of the ventricles
- Explain the importance of the septum in separating oxygenated and deoxygenated blood
- Describe the functioning of the heart in terms of the contraction of muscles of the atria and ventricles and the action of the valves
- Explain the effect of physical activity on the heart rate
- Discuss the roles of diet and exercise in the prevention of coronary heart disease
- Describe ways in which coronary heart disease may be treated, limited to drug treatment with aspirin and surgery (stents, angioplasty and by-pass)

9.3 Blood and lymphatic vessels

Core

- Describe the structure and functions of arteries, veins and capillaries
- Name the main blood vessels to and from the:
  - heart, limited to vena cava, aorta, pulmonary artery and pulmonary vein
  - lungs, limited to the pulmonary artery and pulmonary vein
  - kidney, limited to the renal artery and renal vein

Supplement

- Explain how the structures of arteries, veins and capillaries are adapted for their functions
- State the function of arterioles, venules and shunt vessels
- Outline the lymphatic system in terms of lymphatic vessels and lymph nodes
- Describe the function of the lymphatic system in the circulation of body fluids and the protection of the body from infection

9.4 Blood

Core

- List the components of blood as red blood cells, white blood cells, platelets and plasma
- Identify red and white blood cells, as seen under the light microscope, on prepared slides and in diagrams and photomicrographs
- State the functions of the following components of blood:
  - red blood cells in transporting oxygen, including the role of haemoglobin
  - white blood cells in phagocytosis and antibody production
  - platelets in clotting (details are **not** required)
  - plasma in the transport of blood cells, ions, soluble nutrients, hormones and carbon dioxide

Supplement

- Identify lymphocyte and phagocyte white blood cells, as seen under the light microscope, on prepared slides and in diagrams and photomicrographs
- State the functions of:
  - lymphocytes – antibody production
  - phagocytes – phagocytosis
- Describe the process of clotting as the conversion of fibrinogen to fibrin to form a mesh
- State the roles of blood clotting as preventing blood loss and preventing the entry of pathogens
- Describe the transfer of materials between capillaries and tissue fluid (details of the roles of water potential and hydrostatic pressure are **not** required)

10 Diseases and immunity

10.1 Diseases and immunity

Core

- Define *pathogen* as a disease-causing organism
- Define *transmissible disease* as a disease in which the pathogen can be passed from one host to another
- State that the pathogen for a transmissible disease may be transmitted either through direct contact, e.g. through blood or other body fluids, or indirectly, e.g. from contaminated surfaces or food, from animals, or from the air
- State that the body has defences:
  - mechanical barriers, limited to skin and hairs in the nose
  - chemical barriers, limited to mucus and stomach acid
  - cells, limited to phagocytosis and antibody production by white blood cells
  - which can be enhanced by vaccination

Supplement

- State that antibodies lock on to antigens leading to direct destruction of pathogens, or marking of pathogens for destruction by phagocytes
- Explain how each pathogen has its own antigens, which have specific shapes, so specific antibodies which fit the specific shapes of the antigens are needed
- Define *active immunity* as defence against a pathogen by antibody production in the body
- Explain that active immunity is gained after an infection by a pathogen, or by vaccination
- Explain the process of vaccination:
  - harmless pathogen given which has antigens
  - antigens trigger an immune response by lymphocytes which produce antibodies
  - memory cells are produced that give long-term immunity

continued

10.1 Diseases and immunity continued

Core	Supplement
• Explain the importance of hygienic food preparation, good personal hygiene, waste disposal and sewage treatment in controlling the spread of disease	• Explain the role of vaccination in controlling the spread of diseases
	• Explain that *passive immunity* is short-term defence against a pathogen by antibodies acquired from another individual, e.g. mother to infant • State that memory cells are not produced in passive immunity • Explain the importance of passive immunity for breast-fed infants • State that some diseases are caused by the immune system targeting and destroying body cells, limited to Type 1 diabetes

11 Gas exchange in humans

11.1 Gas exchange in humans

Core	Supplement
• List the features of gas exchange surfaces in humans, limited to large surface area, thin surface, good blood supply and good ventilation with air	
• Name and identify the lungs, diaphragm, ribs, intercostal muscles, larynx, trachea, bronchi, bronchioles, alveoli and associated capillaries	• Name and identify the internal and external intercostal muscles • State the functions of the cartilage in the trachea • 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
• State the differences in composition between inspired and expired air, limited to oxygen, carbon dioxide and water vapour • Use limewater as a test for carbon dioxide to investigate the differences in composition between inspired and expired air	• Explain the differences in composition between inspired and expired air
• Investigate and describe the effects of physical activity on rate and depth of breathing	• Explain the link between physical activity and rate and depth of breathing in terms of the increased carbon dioxide concentration in the blood, detected by the brain, causing an increased rate of breathing • Explain the role of goblet cells, mucus and ciliated cells in protecting the gas exchange system from pathogens and particles

12 Respiration

12.1 Respiration

Core

- State the uses of energy in the body of humans: muscle contraction, protein synthesis, cell division, active transport, growth, the passage of nerve impulses and the maintenance of a constant body temperature
- State that respiration involves the action of enzymes in cells

12.2 Aerobic respiration

Core

- Define *aerobic respiration* as the chemical reactions in cells that use oxygen to break down nutrient molecules to release energy
- State the word equation for aerobic respiration as glucose + oxygen → carbon dioxide + water
- Investigate the uptake of oxygen by respiring organisms, such as arthropods and germinating seeds

Supplement

- State the balanced chemical equation for aerobic respiration as $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$
- Investigate the effect of temperature on the rate of respiration of germinating seeds

12.3 Anaerobic respiration

Core

- Define *anaerobic respiration* as the chemical reactions in cells that break down nutrient molecules to release energy without using oxygen
- State the word equations for anaerobic respiration in muscles during vigorous exercise (glucose → lactic acid) and the microorganism yeast (glucose → alcohol + carbon dioxide)
- State that anaerobic respiration releases much less energy per glucose molecule than aerobic respiration

Supplement

- State the balanced chemical equation for anaerobic respiration in the microorganism yeast as $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$
- State that lactic acid builds up in muscles and blood during vigorous exercise causing an oxygen debt
- Outline how the oxygen debt is removed during recovery, limited to:
  - aerobic respiration of lactic acid in the liver
  - continuation, after exercise, of fast heart rate to transport lactic acid in blood from muscles to the liver
  - continuation, after exercise, of deeper breathing supplying oxygen for aerobic respiration of lactic acid

13 Excretion in humans

13.1 Excretion in humans

Core

- State that urea is formed in the liver from excess amino acids
- State that carbon dioxide is excreted through the lungs
- State that the kidneys excrete urea and excess water and salts
- Explain that the volume and concentration of urine produced is affected by water intake, temperature and exercise
- Identify on drawings, diagrams and images, the ureters, bladder and urethra

Supplement

- Describe the role of the liver in the assimilation of amino acids by converting them to proteins, including plasma proteins, e.g. fibrinogen
- Define *deamination* as the removal of the nitrogen-containing part of amino acids to form urea
- Explain the need for excretion, limited to toxicity of urea and carbon dioxide
- Outline the structure of the kidney, limited to the cortex, medulla and ureter
- Outline the structure and functioning of a kidney tubule, including:
  - the role of the glomerulus in the filtration from the blood of water, glucose, urea and salts
  - the role of the tubule in the reabsorption of all of the glucose, most of the water and some salts back into the blood, leading to the concentration of urea in the urine as well as loss of excess water and salts (details of these processes are **not** required)
- Explain dialysis in terms of salt balance, the maintenance of glucose concentration and the removal of urea
- Describe the use of dialysis in kidney machines
- Discuss the advantages and disadvantages of kidney transplants, compared with dialysis

14 Coordination and response

14.1 Nervous control in humans

Core	Supplement
• Describe a nerve impulse as an electrical signal that passes along nerve cells called neurones	
• Describe the human nervous system in terms of: – the central nervous system consisting of brain and spinal cord – the peripheral nervous system – coordination and regulation of body functions	• Distinguish between voluntary and involuntary actions
• Identify motor (effector), relay (connector) and sensory neurones from diagrams	
• Describe a simple reflex arc in terms of receptor, sensory neurone, relay neurone, motor neurones and effector	
• Describe a reflex action as a means of automatically and rapidly integrating and coordinating stimuli with the responses of effectors (muscles and glands)	
• Define a *synapse* as a junction between two neurones	• Describe the structure of a synapse, including the presence of neurotransmitter containing vesicles, the synaptic cleft and neurotransmitter receptor molecules • Describe how an impulse triggers the release of a neurotransmitter from vesicles into the synaptic gap and how the neurotransmitter diffuses across to bind with receptor molecules, in the membrane of the neurone after the synaptic gap, causing the impulse to continue • State that in a reflex arc the synapses ensure that impulses travel in one direction only • State that many drugs, e.g. heroin, act upon synapses

14.2 Sense organs

Core

- Define *sense organs* as groups of receptor cells responding to specific stimuli: light, sound, touch, temperature and chemicals
- Identify the structures of the eye, limited to cornea, iris, pupil, lens, retina, optic nerve and blind spot
- Describe the function of each part of the eye, limited to:
  - cornea – refracts light
  - iris – controls how much light enters pupil
  - lens – focuses light onto retina
  - retina – contains light receptors, some sensitive to light of different colours
  - optic nerve – carries impulses to the brain
- Explain the pupil reflex in terms of light intensity and pupil diameter only

Supplement

- Explain the pupil reflex in terms of light intensity and antagonistic action of circular and radial muscles in the iris
- 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
- State the distribution of rods and cones in the retina of a human
- Outline the function of rods and cones, limited to greater sensitivity of rods for night vision and three different kinds of cones absorbing light of different colours for colour vision
- Identify the position of the fovea

14.3 Hormones in humans

Core	Supplement
• Define 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	
• Identify specific endocrine glands and their secretions, limited to adrenal glands and adrenaline, pancreas and insulin, testes and testosterone and ovaries and oestrogen	
• Describe adrenaline as the hormone secreted in 'fight or flight' situations and its effects, limited to increased breathing and pulse rate and widened pupils	• Discuss the role of the hormone adrenaline in the chemical control of metabolic activity, including increasing the blood glucose concentration and pulse rate
• Give examples of situations in which adrenaline secretion increases	
	• Compare nervous and hormonal control systems in terms of speed and longevity of action
• State the functions of insulin, oestrogen and testosterone	

14.4 Homeostasis

Core	Supplement
• Define *homeostasis* as the maintenance of a constant internal environment	• Explain that homeostasis is the control of internal conditions within set limits
	• Explain the concept of control by negative feedback
	• Describe the control of the glucose concentration of the blood by the liver and the roles of insulin and glucagon from the pancreas
	• Outline the symptoms and treatment of Type 1 diabetes (detail of β cells is **not** required)
• Name and identify on a diagram of the skin: hairs, hair erector muscles, sweat glands, receptors, sensory neurones, blood vessels and fatty tissue	
• Describe the maintenance of a constant internal body temperature in humans in terms of insulation, sweating, shivering and the role of the brain (limited to blood temperature receptors and coordination)	• Describe the maintenance of a constant internal body temperature in humans in terms of vasodilation and vasoconstriction of arterioles supplying skin surface capillaries

14.5 Tropic responses

Core

- Define *gravitropism* as a response in which parts of a plant grow towards or away from gravity
- Define *phototropism* as a response in which parts of a plant grow towards or away from the direction from which light is coming
- Investigate gravitropism and phototropism in shoots and roots

Supplement

- Explain phototropism and gravitropism of a shoot as examples of the chemical control of plant growth
- Explain the role of auxin in controlling shoot growth, limited to:
  - auxin made in shoot tip (only)
  - auxin spreads through the plant from the shoot tip
  - auxin is unequally distributed in response to light and gravity
  - auxin stimulates cell elongation
- Describe the use in weedkillers of the synthetic plant hormone 2,4-D

15 Drugs

15.1 Drugs

Core

- Define a *drug* as any substance taken into the body that modifies or affects chemical reactions in the body

15.2 Medicinal drugs

Core

- Describe the use of antibiotics for the treatment of bacterial infection
- State that some bacteria are resistant to antibiotics which reduces the effectiveness of antibiotics
- State that antibiotics kill bacteria but do not affect viruses

Supplement

- Explain how development of resistant bacteria such as MRSA can be minimised, limited to using antibiotics only when essential and ensuring treatment is completed
- Explain why antibiotics kill bacteria, but do not affect viruses

15.3 Misused drugs

Core	Supplement
• Describe the effects of excessive alcohol consumption and abuse of heroin, limited to: – powerful depressant drugs – effect on reaction times and self-control – addiction and withdrawal symptoms – negative social implications, e.g. crime	• Explain how heroin affects the nervous system, limited to its effect on the function of synapses
• State that injecting heroin can cause infections such as HIV	
• State that excessive alcohol consumption can cause liver damage	
• State that tobacco smoking can cause chronic obstructive pulmonary disease (COPD), lung cancer and coronary heart disease	• Discuss the evidence for the link between smoking and lung cancer
• Describe the effects on the gas exchange system of tobacco smoke and its major toxic components, limited to carbon monoxide, nicotine and tar	
	• Discuss the use of hormones to improve sporting performance, limited to testosterone and anabolic steroids
• State that the liver is the site of break down of alcohol and other toxins	

16 Reproduction

16.1 Asexual reproduction

Core	Supplement
• Define *asexual reproduction* as a process resulting in the production of genetically identical offspring from one parent	
• Identify examples of asexual reproduction from information provided	
	• Discuss the advantages and disadvantages of asexual reproduction: – to a population of a species in the wild – to crop production

16.2 Sexual reproduction

Core

- Define *sexual reproduction* as a process involving the fusion of the nuclei of two gametes (sex cells) to form a zygote and the production of offspring that are genetically different from each other
- Define *fertilisation* as the fusion of gamete nuclei

Supplement

- State that the nuclei of gametes are haploid and that the nucleus of a zygote is diploid
- Discuss the advantages and disadvantages of sexual reproduction:
  - to a population of a species in the wild
  - to crop production

16.3 Sexual reproduction in plants

Core

- Identify and draw, using a hand lens if necessary, the sepals, petals, stamens, filaments and anthers, carpels, style, stigma, ovary and ovules, of an insect-pollinated flower
- State the functions of the sepals, petals, anthers, stigmas and ovaries
- Use a hand lens to identify and describe the anthers and stigmas of a wind-pollinated flower
- Distinguish between the pollen grains of insect-pollinated and wind-pollinated flowers
- Define *pollination* as the transfer of pollen grains from the anther to the stigma
- State that fertilisation occurs when a pollen nucleus fuses with a nucleus in an ovule
- Describe the structural adaptations of insect-pollinated and wind-pollinated flowers
- Investigate and state the environmental conditions that affect germination of seeds, limited to the requirement for water, oxygen and a suitable temperature

Supplement

- Define *self-pollination* as the transfer of pollen grains from the anther of a flower to the stigma of the same flower or different flower on the same plant
- Define *cross-pollination* as transfer of pollen grains from the anther of a flower to the stigma of a flower on a different plant of the same species
- Discuss the implications to a species of self-pollination and cross-pollination in terms of variation, capacity to respond to changes in the environment and reliance on pollinators
- 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	Supplement
• Identify and name on diagrams of the male reproductive system: the testes, scrotum, sperm ducts, prostate gland, urethra and penis, and state the functions of these parts	
• Identify and name on diagrams of the female reproductive system: the ovaries, oviducts, uterus, cervix and vagina, and state the functions of these parts	
• Describe fertilisation as the fusion of the nuclei from a male gamete (sperm) and a female gamete (egg cell/ovum)	
	• Compare male and female gametes in terms of size, structure, motility and numbers
• State the adaptive features of sperm, limited to flagellum and the presence of enzymes	• Explain the adaptive features of sperm, limited to flagellum, mitochondria and enzymes in the acrosome
• State the adaptive features of egg cells, limited to energy stores and a jelly coating that changes after fertilisation	• Explain the adaptive features of egg cells, limited to energy stores and the jelly coat that changes at fertilisation
• State that in early development, the zygote forms an embryo which is a ball of cells that implants into the wall of the uterus	
• State the functions of the umbilical cord, placenta, amniotic sac and amniotic fluid	• Describe the function of the placenta and umbilical cord in relation to exchange of dissolved nutrients, gases and excretory products and providing a barrier to toxins and pathogens (structural details are **not** required)
• Outline the growth and development of the fetus in terms of increasing complexity in the early stages and increasing size towards the end of pregnancy	• State that some toxins, e.g. nicotine, and pathogens, e.g. rubella virus, can pass across the placenta and affect the fetus
• Describe the antenatal care of pregnant women, limited to special dietary needs and the harm from smoking and alcohol consumption	• Discuss the advantages and disadvantages of breast-feeding compared with bottle-feeding using formula milk
• Outline the processes involved in labour and birth, limited to: – breaking of the amniotic sac – contraction of the muscles in the uterus wall – dilation of the cervix – passage through the vagina – tying and cutting the umbilical cord – delivery of the afterbirth	

16.5 Sex hormones in humans

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

16.6 Methods of birth control in humans

Core	Supplement
• Outline the following methods of birth control: – natural, limited to abstinence, monitoring body temperature and cervical mucus – chemical, limited to IUD, IUS, contraceptive pill, implant and injection – barrier, limited to condom, femidom, diaphragm – surgical, limited to vasectomy and female sterilisation	• Outline the use of hormones in contraception and fertility treatments • Outline artificial insemination (AI) • Outline *in vitro* fertilisation (IVF) • Discuss the social implications of contraception and fertility treatments

16.7 Sexually transmitted infections (STIs)

Core	Supplement
• Define *sexually transmitted infection* as an infection that is transmitted via body fluids through sexual contact • State that human immunodeficiency virus (HIV) is an example of an STI • Explain how the spread of STIs is controlled • Describe the methods of transmission of HIV • State that HIV infection may lead to AIDS	• Outline how HIV affects the immune system, limited to decreased lymphocyte numbers and reduced ability to produce antibodies

17 Inheritance

17.1 Inheritance

Core	Supplement
• Define *inheritance* as the transmission of genetic information from generation to generation	

17.2 Chromosomes, genes and proteins

Core

- Define *chromosome* as a thread-like structure of DNA, carrying genetic information in the form of genes
- Define *gene* as a length of DNA that codes for a protein
- Define *allele* as a version of a gene
- Describe the inheritance of sex in humans with reference to XX and XY chromosomes

Supplement

- Explain that the sequence of bases in a gene is the genetic code for putting together amino acids in the correct order to make a specific protein (knowledge of the details of nucleotide structure is **not** required)
- Explain that DNA controls cell function by controlling the production of proteins (some of which are enzymes), antibodies and receptors for neurotransmitters
- Explain how a protein is made, limited to:
  - the gene coding for the protein remains in the nucleus
  - mRNA molecules carry a copy of the gene to the cytoplasm
  - the mRNA passes through ribosomes
  - the ribosome assembles amino acids into protein molecules
  - the specific order of amino acids is determined by the sequence of bases in the mRNA (knowledge of the details of transcription or translation is **not** required)
- Explain that all 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
- Define a *haploid nucleus* as a nucleus containing a single set of unpaired chromosomes, e.g. in gametes
- Define a *diploid nucleus* as a nucleus containing two sets of chromosomes, e.g. in body cells
- 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

17.3 Mitosis

Core

- Define *mitosis* as nuclear division giving rise to genetically identical cells (details of stages are **not** required)
- State the role of mitosis in growth, repair of damaged tissues, replacement of cells and asexual reproduction

Supplement

- State that the exact duplication of chromosomes occurs before mitosis
- State that during mitosis, the copies of chromosomes separate, maintaining the chromosome number (details of stages of mitosis are **not** required)
- Describe stem cells as unspecialised cells that divide by mitosis to produce daughter cells that can become specialised for specific functions

17.4 Meiosis

Core

- Define *meiosis* as nuclear division giving rise to cells that are genetically different (details of stages are **not** required)
- State that meiosis is involved in the production of gametes

Supplement

- Define *meiosis* as reduction division in which the chromosome number is halved from diploid to haploid resulting in genetically different cells (details of stages are **not** required)
- Explain how meiosis produces variation by forming new combinations of maternal and paternal chromosomes (specific details are **not** required)

17.5 Monohybrid inheritance

Core

- Define *genotype* as the genetic make-up of an organism in terms of the alleles present
- Define *phenotype* as the observable features of an organism
- Define *homozygous* as having two identical alleles of a particular gene
- State that two identical homozygous individuals that breed together will be pure-breeding
- Define *heterozygous* as having two different alleles of a particular gene
- State that a heterozygous individual will not be pure-breeding
- Define *dominant* as an allele that is expressed if it is present
- Define *recessive* as an allele that is only expressed when there is no dominant allele of the gene present
- Interpret pedigree diagrams for the inheritance of a given characteristic
- Use genetic diagrams to predict the results of monohybrid crosses and calculate phenotypic ratios, limited to 1:1 and 3:1 ratios
- Use Punnett squares in crosses which result in more than one genotype to work out and show the possible different genotypes

Supplement

- Explain how to use a test cross to identify an unknown genotype
- Explain co-dominance by reference to the inheritance of ABO blood groups – phenotypes being A, B, AB and O blood groups and alleles being I^A, I^B and I^O
- Define a *sex-linked characteristic* as a characteristic in which the gene responsible is located on a sex chromosome and that this makes it more common in one sex than in the other
- Describe colour blindness as an example of sex linkage
- Use genetic diagrams to predict the results of monohybrid crosses involving co-dominance or sex linkage and calculate phenotypic ratios

18 Variation and selection

18.1 Variation

Core	Supplement
• Define *variation* as differences between individuals of the same species	
• Distinguish between phenotypic variation and genetic variation	• State that phenotypic variation is caused by both genetic and environmental factors
• State that continuous variation results in a range of phenotypes between two extremes, e.g. height in humans	
• State that discontinuous variation results in a limited number of phenotypes with no intermediates, e.g. tongue rolling	• State that discontinuous variation is mostly caused by genes alone, e.g. A, B, AB and O blood groups in humans
• Record and present the results of investigations into continuous and discontinuous variation	
• Define *mutation* as genetic change	• Define *gene mutation* as a change in the base sequence of DNA
• State that mutation is the way in which new alleles are formed	
• State that ionising radiation and some chemicals increase the rate of mutation	
	• Describe the symptoms of sickle-cell anaemia
	• Explain how a change in the base sequence of the gene for haemoglobin results in abnormal haemoglobin and sickle-shaped red blood cells
	• Use genetic diagrams to show how sickle-cell anaemia is inherited
	• State that people who are heterozygous (Hb^S Hb^A) for the sickle-cell allele have a resistance to malaria
	• Explain the distribution of the sickle-cell allele in human populations with reference to the distribution of malaria
	(Teaching of human inherited conditions should be done with sensitivity at all times.)

18.2 Adaptive features

Core	Supplement
• Define *adaptive feature* as an inherited feature that helps an organism to survive and reproduce in its environment	• Define *adaptive feature* as the inherited functional features of an organism that increase its fitness
• Interpret images or other information about a species to describe its adaptive features	
	• Define *fitness* as the probability of an organism surviving and reproducing in the environment in which it is found
	• Explain the adaptive features of hydrophytes and xerophytes to their environments

18.3 Selection

Core

- Describe natural selection with reference to:
  - variation within populations
  - production of many offspring
  - competition for resources
  - struggle for survival
  - reproduction by individuals that are better adapted to the environment than others
  - passing on of their alleles to the next generation
- Describe selective breeding with reference to:
  - selection by humans of individuals with desirable features
  - crossing these individuals to produce the next generation
  - selection of offspring showing the desirable features

Supplement

- Describe evolution as the change in adaptive features of a population over time as the result of natural selection
- Define the *process of adaptation* as the process, resulting from natural selection, by which populations become more suited to their environment over many generations
- Describe the development of strains of antibiotic resistant bacteria as an example of evolution by natural selection
- State the differences between natural and artificial selection
- Outline how selective breeding by artificial selection is carried out over many generations to improve crop plants and domesticated animals

19 Organisms and their environment

19.1 Energy flow

Core

- State that the Sun is the principal source of energy input to biological systems

Supplement

- 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

- Define a *food chain* as showing the transfer of energy from one organism to the next, beginning with a producer
- State that energy is transferred between organisms in a food chain by ingestion
- Construct simple food chains

Supplement

- Describe how energy is transferred between trophic levels
- Define *trophic level* as the position of an organism in a food chain, food web, pyramid of numbers or pyramid of biomass
- Explain why the transfer of energy from one trophic level to another is inefficient
- Explain why food chains usually have fewer than five trophic levels

continued

19.2 Food chains and food webs continued

Core	Supplement
	• Explain why there is a greater efficiency in supplying plants as human food, and that there is a relative inefficiency in feeding crop plants to livestock that will be used as food
• Define a *food web* as a network of interconnected food chains • Define *producer* as an organism that makes its own organic nutrients, usually using energy from sunlight, through photosynthesis • Define *consumer* as an organism that gets its energy by feeding on other organisms	
• State that consumers may be classed as primary, secondary and tertiary according to their position in a food chain	• Identify producers, primary consumers, secondary consumers, tertiary consumers and quaternary consumers as the trophic levels in food webs, food chains, pyramids of numbers and pyramids of biomass
• Define *herbivore* as an animal that gets its energy by eating plants • Define *carnivore* as an animal that gets its energy by eating other animals • Define *decomposer* as an organism that gets its energy from dead or waste organic material • Interpret food chains and food webs in terms of identifying producers and consumers • Use food chains and food webs to describe the impacts humans have through over-harvesting of food species and through introducing foreign species to a habitat	
• Draw, describe and interpret pyramids of numbers	• Draw, describe and interpret pyramids of biomass • Discuss the advantages of using a pyramid of biomass rather than a pyramid of numbers to represent a food chain

19.3 Nutrient cycles

Core

- Describe the carbon cycle, limited to photosynthesis, respiration, feeding, decomposition, fossilisation and combustion
- Discuss the effects of the combustion of fossil fuels and the cutting down of forests on the carbon dioxide concentrations in the atmosphere
- Describe the water cycle, limited to evaporation, transpiration, condensation and precipitation

Supplement

- Describe the nitrogen cycle in terms of:
  - 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
- 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 Population size

Core	Supplement
• Define *population* as a group of organisms of one species, living in the same area, at the same time	
	• Define *community* as all of the populations of different species in an ecosystem • Define *ecosystem* as a unit containing the community of organisms and their environment, interacting together, e.g. a decomposing log, or a lake
• Identify and state the factors affecting the rate of population growth for a population of an organism, limited to food supply, predation and disease	• Identify the lag, exponential (log), stationary and death phases in the sigmoid population growth curve for a population growing in an environment with limited resources • 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
• Discuss the increase in human population size over the past 250 years and its social and environmental implications • Interpret graphs and diagrams of human population growth	

20 Biotechnology and genetic engineering

20.1 Biotechnology and genetic engineering

Core	Supplement
• State that bacteria are useful in biotechnology and genetic engineering due to their rapid reproduction rate and their ability to make complex molecules	• Discuss why bacteria are useful in biotechnology and genetic engineering, limited to: – lack of ethical concerns over their manipulation and growth – genetic code shared with all other organisms – presence of plasmids

20.2 Biotechnology

Core

- Describe the role of anaerobic respiration in yeast during production of ethanol for biofuels
- Describe the role of anaerobic respiration in yeast during bread-making
- Investigate and describe the use of pectinase in fruit juice production
- Investigate and describe the use of biological washing powders that contain enzymes

Supplement

- Investigate and explain the use of lactase to produce lactose-free milk
- Describe the role of the fungus *Penicillium* in the production of the antibiotic penicillin
- Explain how fermenters are used in the production of penicillin

20.3 Genetic engineering

Core

- Define *genetic engineering* as changing the genetic material of an organism by removing, changing or inserting individual genes
- State examples of genetic engineering:
  - the insertion of human genes into bacteria to produce human insulin
  - the insertion of genes into crop plants to confer resistance to herbicides
  - the insertion of genes into crop plants to confer resistance to insect pests
  - the insertion of genes into crop plants to provide additional vitamins

Supplement

- Outline genetic engineering using bacterial production of a human protein as an example, limited to:
  - isolation of the DNA making up a human gene using restriction enzymes, forming sticky ends
  - cutting of bacterial plasmid DNA with the same restriction enzymes, forming complementary sticky ends
  - insertion of human DNA into bacterial plasmid DNA using DNA ligase to form a recombinant plasmid
  - insertion of plasmid into bacteria (specific detail is **not** required)
  - replication of bacteria containing recombinant plasmids which make human protein as they express the gene
- Discuss the advantages and disadvantages of genetically modifying crops, such as soya, maize and rice

21 Human influences on ecosystems

21.1 Food supply

Core

- State how modern technology has resulted in increased food production in terms of:
  - agricultural machinery to use larger areas of land and improve efficiency
  - chemical fertilisers to improve yields
  - insecticides to improve quality and yield
  - herbicides to reduce competition with weeds
  - selective breeding to improve production by crop plants and livestock, e.g. cattle, fish and poultry
- Describe the negative impacts to an ecosystem of large-scale monocultures of crop plants
- Describe the negative impacts to an ecosystem of intensive livestock production

Supplement

- Discuss the social, environmental and economic implications of providing sufficient food for an increasing human global population
- Discuss the problems which contribute to famine including unequal distribution of food, drought and flooding, increasing population and poverty

21.2 Habitat destruction

Core

- Describe the reasons for habitat destruction, limited to:
  - increased area for food crop growth, livestock production and housing
  - extraction of natural resources
  - marine pollution
- State that through altering food webs and food chains, humans can have a negative impact on habitats
- List the undesirable effects of deforestation as an example of habitat destruction, to include extinction, loss of soil, flooding and increase of carbon dioxide in the atmosphere

Supplement

- Explain the undesirable effects of deforestation on the environment

21.3 Pollution

Core

- State the sources and effects of pollution of land and water, e.g. rivers, lakes and the sea, by insecticides, herbicides and by nuclear fall-out
- State the sources and effects of pollution of water (rivers, lakes and the sea) by chemical waste, discarded rubbish, untreated sewage and fertilisers
- State the sources and effects of pollution of the air by methane and carbon dioxide, limited to the enhanced greenhouse effect and climate change

Supplement

- Explain the process of eutrophication of water in terms of:
  - 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
- Discuss the effects of non-biodegradable plastics in the environment, in both aquatic and terrestrial ecosystems
- Discuss the causes and effects on the environment of acid rain
- State the measures that are taken to reduce sulfur dioxide pollution and reduce the impact of acid rain
- Explain how increases in carbon dioxide and methane concentrations in the atmosphere cause an enhanced greenhouse effect that leads to climate change
- Describe the negative impacts of female contraceptive hormones in water courses, limited to reduced sperm count in men and feminisation of aquatic organisms

21.4 Conservation

Core

- Define a *sustainable resource* as one which is produced as rapidly as it is removed from the environment so that it does not run out
- Explain the need to conserve non-renewable resources, limited to fossil fuels
- State that some resources can be maintained, limited to forests and fish stocks
- State that products can be reused or recycled, limited to paper, glass, plastic and metal
- Outline how sewage is treated to make the water that it contains safe to return to the environment or for human use
- Explain why organisms become endangered or extinct, limited to climate change, habitat destruction, hunting, pollution and introduced species
- Describe how endangered species can be conserved, limited to monitoring and protecting species and habitats, education, captive breeding programmes and seed banks

Supplement

- Define the term *sustainable development* as development providing for the needs of an increasing human population without harming the environment
- Explain how forests and fish stocks can be sustained using education, legal quotas and restocking
- Explain that sustainable development requires:
  - management of conflicting demands
  - planning and co-operation at local, national and international levels
- Explain the risks to a species if the population size drops, reducing variation (knowledge of genetic drift is **not** required)
- Explain reasons for conservation programmes, to include:
  - reducing extinction
  - protecting vulnerable environments
  - maintaining ecosystem functions, limited to nutrient cycling and resource provision, e.g. food, drugs, fuel and genes

4 Details of the assessment

All candidates take three papers.

Core Assessment

Core candidates take the following papers that have questions based on the Core subject content only:

Paper 1 – Multiple Choice (Core)

45 minutes, 40 marks

Forty compulsory multiple-choice items of the four-choice type. This paper tests assessment objectives AO1 and AO2.

Paper 3 – Theory (Core)

1 hour 15 minutes, 80 marks

Short-answer and structured questions testing assessment objectives AO1 and AO2.

Extended Assessment

Extended candidates take the following papers that have questions based on the Core and Supplement subject content:

Paper 2 – Multiple Choice (Extended)

45 minutes, 40 marks

Forty compulsory multiple-choice items of the four-choice type. This paper tests assessment objectives AO1 and AO2.

Paper 4 – Theory (Extended)

1 hour 15 minutes, 80 marks

Short-answer and structured questions testing assessment objectives AO1 and AO2.

Practical Assessment

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

Paper 5 – Practical Test

1 hour 15 minutes, 40 marks

This paper tests assessment objective AO3 in a practical context.

or

Paper 6 – Alternative to Practical Test

1 hour, 40 marks

This paper tests assessment objective AO3 in a written paper.

Whichever practical paper you choose please be aware that:

- they test the same assessment objective, AO3
- they require the same experimental skills to be learned and developed
- the same sequence of practical activities is appropriate.

Candidates must not use textbooks or any of their course notes in the practical component.

Questions in the practical papers are structured to assess performance across the grade range 1 to 9. The information candidates need to answer the questions is in the question paper itself or the experimental context and skills listed below. The questions do not assess specific syllabus content.

Experimental skills tested in Paper 5 Practical Test and Paper 6 Alternative to Practical

Candidates may be asked questions on the following experimental contexts:

- recall of familiar, and unfamiliar, techniques to record observations and make deductions from them
- recall of simple chemical tests, e.g. for food substances and the use of hydrogencarbonate indicator, litmus and universal indicator paper
- recognise, observe, record and measure images of familiar, and unfamiliar, biological specimens
- making a clear line drawing from an image of a specimen, calculating the magnification and adding labels as required.

Candidates may be required to do the following:

- carefully follow a sequence of instructions
- record readings from diagrams of apparatus, including:
  - reading a scale with appropriate accuracy and precision
  - interpolating between scale divisions
  - taking repeated measurements, where appropriate, to obtain an average value
- describe, explain or comment on experimental arrangements and techniques
- interpret and evaluate observations and experimental data
- complete tables of data, and process data, using a calculator where necessary
- perform simple arithmetical calculations

- plot graphs and/or interpret graphical information
- draw an appropriate conclusion, justifying it by reference to the data and using an appropriate explanation
- identify sources of error and suggest possible improvements in procedures
- plan an experiment or investigation, including making reasoned predictions of expected results and suggesting suitable apparatus and techniques.

Teaching experimental skills

We expect you to look for suitable opportunities to embed practical techniques and investigative work throughout the course.

The best way to prepare candidates for these papers is to integrate practical work fully into the course so that it becomes a normal part of your teaching. Practical work helps candidates to:

- develop a deeper understanding of the syllabus topics
- learn to appreciate the way in which scientific theories are developed and tested
- develop experimental skills and positive scientific attitudes such as objectivity, integrity, cooperation, enquiry and inventiveness.

Apparatus list

This list contains the items you will need for teaching the experimental skills needed for both practical papers, as well as the Paper 5 exam. It is not exhaustive and does not include standard equipment such as Bunsen burners, tripods, and hot water-baths. The *Confidential Instructions* we send you before the Paper 5 exam will give the detailed requirements for the exam.

- rulers capable of measuring to 1 mm
- mounted needles or seekers or long pins with large heads
- means of cutting biological materials such as scalpels, solid-edged razor blades or knives
- scissors
- forceps
- means of writing on glassware
- beakers, 100 cm^3, 250 cm^3
- test-tubes, 125 mm × 15 mm and 150 mm × 25 mm including some hard-glass test-tubes and a means of holding them (e.g. rack)
- means of measuring small and larger volumes of liquids such as syringes and measuring cylinders
- dropping pipette
- white tile
- spotting tile
- hand lens ×6 magnification
- thermometer, –10 °C to +110 °C at 1 °C graduations
- clock (or wall-clock or wrist-watch), to measure to an accuracy of 1 s
- funnels
- Petri dishes
- syringes
- glass rods
- chemicals (e.g. for food tests, limewater)
- indicators (litmus paper, universal indicator paper, hydrogencarbonate indicator).

Glossary of terms used in science papers

This glossary (which is relevant only to science subjects) will prove helpful to candidates as a guide, but it is neither exhaustive nor definitive. The glossary has been deliberately kept brief, not only with respect to the number of terms included, but also to the descriptions of their meanings. Candidates should appreciate that the meaning of a term must depend, in part, on its context.

1 *Define* (the term(s) …) is intended literally, only a formal statement or equivalent paraphrase being required.

2 *What do you understand by/What is meant by* (the term(s) …) normally implies that a definition should be given, together with some relevant comment on the significance or context of the term(s) concerned, especially where two or more terms are included in the question. The amount of supplementary comment intended should be interpreted in the light of the indicated mark value.

3 *State* implies a concise answer with little or no supporting argument (e.g. a numerical answer that can readily be obtained 'by inspection').

4 *List* requires a number of points, generally each of one word, with no elaboration. Where a given number of points is specified this should not be exceeded.

5 (a) *Explain* may imply reasoning or some reference to theory, depending on the context. It is another way of asking candidates to give reasons. The candidate needs to leave the examiner in no doubt why something happens.

(b) *Give a reason/Give reasons* is another way of asking candidates to explain why something happens.

6 *Describe* requires the candidate to state in words (using diagrams where appropriate) the main points.

Describe and *explain* may be coupled, as may *state* and *explain*.

7 *Discuss* requires the candidate to give a critical account of the points involved.

8 *Outline* implies brevity (i.e. restricting the answer to giving essentials).

9 *Predict* implies that the candidate is expected to make a prediction not by recall but by making a logical connection between other pieces of information.

10 *Deduce* implies that the candidate is not expected to produce the required answer by recall but by making a logical connection between other pieces of information.

11 *Suggest* is used in two main contexts, i.e. either to imply that there is no unique answer (e.g. in biology there are a variety of factors that might limit the rate of photosynthesis of a plant in a greenhouse), or to imply that candidates are expected to apply their general knowledge of the subject to a 'novel' situation, one that may be formally 'not in the syllabus' – many data response and problem-solving questions are of this type.

12 *Find* is a general term that may variously be interpreted as *calculate*, *measure*, *determine*, etc.

13 *Calculate* is used when a numerical answer is required. In general, working should be shown, especially where two or more steps are involved.

14 *Measure* implies that the quantity concerned can be directly obtained from a suitable measuring instrument (e.g. length using a rule, or mass using a balance).

15 *Determine* often implies that the quantity concerned cannot be measured directly but is obtained from a graph or by calculation.

16 *Estimate* implies a reasoned order of magnitude statement or calculation of the quantity concerned, making such simplifying assumptions as may be necessary about points of principle and about the values of quantities not otherwise included in the question.

17 *Sketch*, when applied to graph work, implies that the shape and/or position of the curve need only be qualitatively correct, but candidates should be aware that, depending on the context, some quantitative aspects may be looked for (e.g. passing through the origin, having an intercept).

In diagrams, *sketch* implies that simple, free-hand drawing is acceptable; nevertheless, care should be taken over proportions and the clear exposition of important details.

5 Appendix

Safety in the laboratory

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 2009 (available to CLEAPSS members only)
CLEAPSS Hazcards, 2007 update of 1995 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

Calculators may be used in all parts of the examination.

Candidates should be able to:

- add, subtract, multiply and divide
- use averages, decimals, fractions, percentages, ratios and reciprocals
- use standard notation, including both positive and negative indices
- understand significant figures and use them appropriately
- recognise and use direct and inverse proportion
- use positive, whole number indices in algebraic expressions
- draw charts and graphs from given data
- interpret charts and graphs
- determine the gradient and intercept of a graph
- select suitable scales and axes for graphs
- make approximate evaluations of numerical expressions
- recall and use equations for the areas of a rectangle, triangle and circle and the volumes of a rectangular block and a cylinder
- use mathematical instruments (ruler, compasses, protractor and set square)
- understand the meaning of angle, curve, circle, radius, diameter, circumference, square, parallelogram, rectangle and diagonal
- solve equations of the form $x = y + z$ and $x = yz$ for any one term when the other two are known.

Presentation of data

The solidus (/) is to be used for separating the quantity and the unit in tables, graphs and charts, e.g. time / s for time in seconds.

(a) Tables

- Each column of a table should be headed with the physical quantity and the appropriate unit, e.g. time / s.
- The column headings of the table can then be directly transferred to the axes of a constructed graph.

(b) Graphs

- 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).
- Each axis should be labelled with the physical quantity and the appropriate unit, e.g. time / s.
- Unless otherwise instructed 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 graph is the whole diagrammatic presentation, including the best-fit line when appropriate. It may have one or more sets of data plotted on it.
- Points on the graph should be clearly marked as crosses (×) or encircled dots (⊙).
- Large 'dots' are penalised. Each data point should be plotted to an accuracy of better than one half of each 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.

(c) Numerical results

- Data should be recorded so as to reflect the precision of the measuring instrument.
- The number of significant figures given for calculated quantities should be appropriate to the least number of significant figures in the raw data used.

(d) Pie charts

- These should be drawn with the sectors in rank order, largest first, beginning at 'noon' and proceeding clockwise. Pie charts should preferably contain no more than six sectors.

(e) Bar charts

- These should be drawn when one of the variables is not numerical. They should be made up of narrow blocks of equal width that do **not** touch.

(f) Histograms

- These should be drawn when plotting frequency graphs with continuous data. The blocks should be drawn in order of increasing or decreasing magnitude and they **should** touch.

ICT opportunities

In order to play a full part in modern society, candidates need to be confident and effective users of ICT. This syllabus provides candidates with a wide range of opportunities to use ICT in their study of biology.

Opportunities for ICT include:

- gathering information from the internet, DVDs and CD-ROMs
- gathering data using sensors linked to data-loggers or directly to computers
- using spreadsheets and other software to process data
- using animations and simulations to visualise scientific ideas
- using software to present ideas and information on paper and on screen.

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

Syllabuses and question papers conform with generally 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).*

Litre/dm^3

To avoid any confusion concerning the symbol for litre, **dm^3** will be used in place of l or litre.

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 whole numbers, e.g. 4 256 789.

6 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/examsofficers**

Before you start

Previous study

We recommend that learners starting this course should have studied a biology curriculum such as the Cambridge Lower Secondary programme or equivalent national educational framework such as the Key Stage 3 programme of study within the National Curriculum for England.

Guided learning hours

We design Cambridge IGCSE syllabuses based on learners having about 130 guided learning hours for each subject during the course but this is for guidance only. The number of hours a learner needs to achieve the qualification may vary according to local practice and their previous experience of the subject.

Availability and timetables

You can enter candidates in the June and November exam series. You can view the timetable for your administrative zone at **www.cambridgeinternational.org/timetables**

All Cambridge schools are allocated to one of six administrative zones. Each zone has a specific timetable. This syllabus is **not** available in all administrative zones. To find out about the availability visit the syllabus page at **www.cambridgeinternational.org/igcse**

Private candidates can enter for this syllabus.

Combining with other syllabuses

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

- Cambridge IGCSE Biology (0610)
- 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.

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 a copy of 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 one 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 your 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/examsofficers**

Retakes

Candidates can retake the whole qualification as many times as they want to. This is a linear qualification so candidates cannot re-sit individual components.

Equality and inclusion

We have taken great care to avoid bias of any kind in the preparation of this syllabus and related assessment materials. In compliance with the UK Equality Act (2010) we have designed this qualification to avoid any direct and indirect discrimination.

The standard assessment arrangements may present unnecessary barriers for candidates with disabilities or learning difficulties. We can put arrangements in place for these candidates to enable them to access the assessments and receive recognition of their attainment. We do not agree access arrangements if they give candidates an unfair advantage over others or if they compromise the standards being assessed.

Candidates who cannot access the assessment of any component may be able to receive an award based on the parts of the assessment they have completed.

Information on access arrangements is in the *Cambridge Handbook (UK)* at **www.cambridgeinternational.org/examsofficers**

Language

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

After the exam

Grading and reporting

Grades 1, 2, 3, 4, 5, 6, 7, 8 or 9 indicate the standard a candidate achieved at Cambridge IGCSE (9–1).

9 is the highest and 1 is the lowest. 'Ungraded' means that the candidate's performance did not meet the standard required for grade 1. '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 (result pending)
- X (no result)
- Y (to be issued)

These letters do not appear on the certificate.

How students and teachers can use the grades

Assessment at Cambridge IGCSE has two purposes.

- To measure learning and achievement.

  The assessment:

  – confirms achievement and performance in relation to the knowledge, understanding and skills specified in the syllabus, to the levels described in the grade descriptions.
- 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

  – help students choose the most suitable course or career.

Grade descriptions

Grade descriptions are provided to give an indication of the standards of achievement candidates awarded particular grades are likely to show. Weakness in one aspect of the examination may be balanced by a better performance in some other aspect.

Grade descriptions for Cambridge IGCSE (9–1) Biology will be published after the first assessment of the IGCSE in 2020. Find more information at **www.cambridgeinternational.org/igcse**

Changes to this syllabus for 2020 and 2021

The syllabus has been updated. This is version 1, published September 2017.

The syllabus and specimen papers have been updated with the new name for Cambridge Assessment International Education.

You are strongly advised to read the whole syllabus before planning your teaching programme.

Any textbooks endorsed to support the syllabus for examination from 2016 are still suitable for use with this syllabus.

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

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

Cambridge Assessment International Education
1 Hills Road, Cambridge, CB1 2EU, United Kingdom
Tel: +44 (0)1223 553554 Fax: +44 (0)1223 553558
Email: info@cambridgeinternational.org www.cambridgeinternational.org