GCSE

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Part of WJEC

WJEC Eduqas GCSE in BIOLOGY

ACCREDITED BY OFQUAL

SPECIFICATION

Teaching from 2016
For award from 2018

Version 3 January 2019

wjec
cbac

This Ofqual regulated qualification is not available for candidates in maintained schools and colleges in Wales.

SUMMARY OF AMENDMENTS

Version	Description	Page number
2	Section 4.1 amended to show the last assessment opportunity for this qualification.	38
3	'Making entries' section has been amended to clarify resit rules.	38

WJEC Eduqas GCSE (9-1) in BIOLOGY

For teaching from 2016
For award from 2018

GCSE BIOLOGY

SUMMARY OF ASSESSMENT

Component 1: Concepts in Biology **Written examination: 2 hours 15 minutes** **75% of qualification**
A mix of short answer questions, structured questions, extended writing and data response questions, with some set in a practical context
Component 2: Applications in Biology **Written examination: 1 hour 15 minutes** **25% of qualification**
Section A (FT) / Section B (HT): A mix of short answer questions, structured questions, extended writing and data response questions, all set in a practical context Section B (FT) / Section A (HT): A resource booklet containing an unseen article will provide the basis for a mix of short answer questions, structured questions and data response questions

This linear qualification will be available in May/June each year. It will be awarded for the first time in summer 2018.

Learners entered for this qualification must sit both components at either foundation or higher tier, in the same examination series.

Qualification Accreditation Number: 601/8660/4

GCSE BIOLOGY

1 INTRODUCTION

1.1 Aims and objectives

The WJEC Eduqas GCSE in Biology provides a broad, coherent, satisfying and worthwhile course of study. It encourages learners to develop confidence in, and a positive attitude towards, science and to recognise its importance in their own lives and to society.

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

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

This specification is intended to promote a variety of styles of teaching and learning so that the course is enjoyable for all participants. Learners will be introduced to a wide range of scientific principles which will allow them to enjoy a positive learning experience. Practical work is an intrinsic part of science. It is imperative that practical skills are developed throughout this course and that an investigatory approach is promoted.

1.2 Prior learning and progression

There are no previous learning requirements for this specification. Any requirements set for entry to a course based on this specification are at the school/college's discretion.

This specification builds on subject content which is typically taught at key stage 3 and provides a suitable foundation for the study of Biology at either AS or A level and Level 3 Science qualifications. In addition, the specification provides a coherent, satisfying and worthwhile course of study for learners who do not progress to further study in this subject.

1.3 Equality and fair access

This specification may be followed by any learner, irrespective of gender, ethnic, religious or cultural background. It has been designed to avoid, where possible, features that could, without justification, make it more difficult for a learner to achieve because they have a particular protected characteristic.

The protected characteristics under the Equality Act 2010 are age, disability, gender reassignment, pregnancy and maternity, race, religion or belief, sex and sexual orientation.

The specification has been discussed with groups who represent the interests of a diverse range of learners, and the specification will be kept under review.

Reasonable adjustments are made for certain learners in order to enable them to access the assessments (e.g. candidates are allowed access to a Sign Language Interpreter, using British Sign Language). Information on reasonable adjustments is found in the following document from the Joint Council for Qualifications (JCQ): *Access Arrangements and Reasonable Adjustments: General and Vocational Qualifications.*

This document is available on the JCQ website (www.jcq.org.uk). As a consequence of provision for reasonable adjustments, very few learners will have a complete barrier to any part of the assessment.

2 SUBJECT CONTENT

This section outlines the knowledge, understanding and skills to be developed by learners studying GCSE Biology.

Learners should be prepared to apply the knowledge, understanding and skills specified in a range of theoretical, practical, industrial and environmental contexts.

Learners' understanding of the connections between the different elements of the subject and their holistic understanding of the subject is a requirement of all GCSE specifications. In practice, this means that learners will be required to draw together different areas of knowledge, skills and understanding from across the full course of study.

Practical work is an intrinsic part of this specification. It is vitally important in developing a conceptual understanding of many topics and it enhances the experience and enjoyment of science. The practical skills developed are also fundamentally important to learners going on to further study in science and related subjects, and are transferable to many careers.

This section includes **specified practical work** that **must** be undertaken by learners in order that they are suitably prepared for the written examinations. The completion of this practical work will develop the skills listed in Appendix A. Appendix B lists the practical technique requirements with exemplification in the context of GCSE Biology.

Appendix C lists the mathematical skills that will be assessed. For the foundation tier, the mathematics will be assessed at levels not lower than expected at KS3. For the higher tier, the mathematics will be assessed at levels not lower than that for foundation tier GCSE Mathematics.

All content in the specification should be introduced in such a way that it enables learners to:

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

The specification content is organised in topics. Each topic contains the following:

- An **overview** which sums up the content of each topic.

- **Working scientifically** - this section summarises how 'working scientifically' may be developed in the topic. The 'working scientifically' section forms part of the assessable content. All of the 'working scientifically' skills listed in Appendix A are referred to at least once in one of these sections.

- **Maths skills** - a summary of mathematical skills that should be developed in each topic. The mathematical statements in this section are part of the assessable content. All of the 'mathematical skills' in Appendix B are referred to at least once in one of these sections.

- **Content statements** - 'Learner's should be able to …' These statements clarify the breadth and depth of the content for each topic. In some cases these statements may be grouped into subtopics.

- **Specified practical work** - this section includes **specified practical work** that **must** be undertaken by learners in order that they are suitably prepared for the written examinations. The completion of this practical work will develop the skills listed in Appendix A. Appendix B lists the practical technique requirements with exemplification in the context of GCSE Biology. Practical work forms part of the assessable content.

Some areas of the content have been selected for assessment at higher tier only. This content is shown in **bold type**. All content may therefore be examined at higher tier but that in bold will not be examined on foundation tier papers.

2.1 Component 1

CONCEPTS IN BIOLOGY

Written examination: 2 hour 15 minutes
75% of qualification
120 marks

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

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

TOPICS

1. Cell biology

1.1 Prokaryotic and eukaryotic cells
1.2 Growth and development of cells
1.3 Cell metabolism

2. Transport systems

2.1 Transport in cells
2.2 Transport systems in humans
2.3 Transport systems in plants

3. Health, disease and the development of medicine

3.1 Health and disease
3.2 Communicable disease
3.3 Treating, curing and preventing disease
3.4 Non-communicable diseases in humans

4. Coordination and control

4.1 Nervous coordination and control in humans
4.2 Hormonal coordination and control in humans
4.3 Homeostasis in humans
4.4 Plant hormones

5. Photosynthesis

6. Ecosystems

6.1 Levels of organisation within an ecosystem
6.2 The principle of material cycling
6.3 Biodiversity
6.4 Some of the biological challenges of increasing food yields using fewer resources

7. Inheritance, variation and evolution

7.1 The genome and gene expression
7.2 Inheritance
7.3 Variation and evolution
7.4 Selective breeding and gene technology

1. CELL BIOLOGY

Overview

The fundamental units of living organisms are cells, which may be part of highly adapted structures including tissues, organs and organ systems, enabling living processes to be performed effectively. Organic compounds are used as fuels in respiration within these cells to allow the other chemical reactions necessary for life. This topic explores the structure and function of cells, how they divide and some metabolic processes that occur within them.

Working scientifically

This topic contains opportunities for learners to understand how scientific methods and theories develop over time by considering the understanding of cell structure in relation to the development of the microscope. It gives learners the opportunity to make and record observations when examining plant and animal cells. It presents the opportunity for learners to carry out experiments appropriately having due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations when investigating factors affecting enzyme action and in the quantitative identification of biological molecules. Learners should also explain the technological applications of science in the application of stem cell technology and consider the ethical issues which may arise from this.

Mathematical skills

There are a number of opportunities for the development of mathematical skills within this topic. In the microscope work in the content on cell structure, an understanding of number, size and scale and the quantitative relationship between units can be developed. When completing the practical work on enzymes, learners should develop the use of estimations and explain when they should be used. They should also be able to carry out rate calculations for chemical reactions. **Higher tier learners should also be able to calculate with numbers written in standard form.**

1.1 PROKARYOTIC AND EUKARYOTIC CELLS

Learners should be able to:

(a) draw and label animal and plant cells

(b) describe the differences between eukaryotic and prokaryotic cells

(c) explain how the following sub-cellular structures of eukaryotic cells (plants and animals) and prokaryotic cells (bacteria) are related to their functions: nucleus/DNA, plasmids, mitochondria, chloroplasts, cell membranes, cytoplasm, vacuole, cell wall

(d) explain how the development of the microscope (light, electron, laser imaging) increased the understanding of the sub cellular structure of organisms and the proposal that the cell is the basic unit of life

SPECIFIED PRACTICAL WORK

- SP1.1 Examination of plant and animal cells using a light microscope and production of labelled scientific drawings from observation

1.2 GROWTH AND DEVELOPMENT OF CELLS

Learners should be able to:

(a) describe the process of mitosis in growth, including the cell cycle; cell division by mitosis enables organisms to grow, replace worn out cells and repair damaged tissues

(b) explain the importance of cell differentiation to produce specialised cells for greater efficiency

(c) describe cancer as the result of changes in cells that lead to uncontrolled growth and division

(d) describe the function of stem cells in embryonic and adult animals and meristems in plants; some cells, both plant and animal, do not lose the ability to differentiate and are called stem cells

(e) discuss the potential benefits, risks and ethical issues surrounding stem cell technology in medicine including the implications for society e.g. the use of embryonic stem cells

(f) explain the role of meiotic cell division in halving the chromosome number to form gametes; each meiotic division produces four cells that are genetically different because genes separate and are reshuffled during the process of gamete formation

1.3 CELL METABOLISM

Learners should be able to:

(a) explain that chemical reactions in cells are controlled by enzymes. Enzymes are proteins made by living cells. Different proteins are composed of different amino acids linked together to form a chain which is then folded to form a specific shape held by chemical bonds. The specific shape of an enzymes active site enables it to function. This is called the 'lock and key' hypothesis. Enzymes function by the formation of the enzyme-substrate complex at the active site

(b) explain that enzymes speed up/catalyse the rate of chemical reactions. Each enzyme has its own optimum pH and temperature. Interpret enzyme activity in terms of molecular collisions. Boiling denatures most enzymes by altering their shape

(c) describe cellular respiration as an exothermic reaction which is continuously occurring in all living cells, enabling cells to carry out cell processes. Aerobic respiration occurs in cells when oxygen is available. It is a series of chemical reactions within the cell, controlled by enzymes. Glucose and oxygen are used and carbon dioxide, water and energy are produced. The energy released is in the form of ATP. Recall the word equation for aerobic respiration

(d) explain that in the absence of oxygen, anaerobic respiration may occur. This is less efficient than aerobic respiration. In humans energy is released from glucose and lactic acid is produced. An oxygen debt may occur. In yeast, glucose is broken down and ethanol and carbon dioxide are produced. Recall the word equation for anaerobic respiration in human cells and fermentation in yeast. Explain that there is less ATP released per molecule of glucose in anaerobic respiration than in aerobic respiration because of the incomplete breakdown of glucose

(e) compare the processes of aerobic and anaerobic respiration

(f) explain that fats, made up of fatty acids and glycerol, proteins, made up of amino acids, and starch (a carbohydrate), made up of a chain of glucose molecules, in our food are insoluble. They are broken down during digestion into soluble substances so that they can be absorbed

(g) explain the importance of the digested products of fats, carbohydrates and proteins. Fatty acids and glycerol from the breakdown of lipids and glucose from the breakdown of carbohydrate are needed for respiration. Amino acids from digested proteins are needed to synthesise proteins in the body

SPECIFIED PRACTICAL WORK

- SP1.3A Investigation into factors affecting enzyme action
- SP1.3B Qualitative identification of starch (iodine), glucose (Benedict's) and protein (biuret)

2. TRANSPORT SYSTEMS

Overview

This topic covers the different mechanisms by which organisms transport substances into and out of cells. This is then developed further into a more detailed consideration of the structure and function of the transport system in humans and plants.

Working scientifically

The use of Visking tubing in this topic provides an opportunity for learners to use a model to develop scientific explanations. The investigation into the effect of solute concentration on osmosis gives learners the opportunity to plan experiments in order to make observations, to interpret observations, identify patterns and trends and draw conclusions. The transpiration investigation can develop learners' skills in the evaluation of the method used and can lead to the suggestion of possible improvements and further investigations. This also provides good opportunities to develop learners' analytical skills by evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error. The microscope work used in the observation of blood vessels and leaf section can develop the use of scientific terminology and the idea of order of magnitude.

Mathematical skills

There are a number of opportunities for the development of mathematical skills within this topic. The calculation of surface area:volume ratios in the understanding of the need for a gas exchange surface in multicellular organisms can develop the use of ratios. Learners should be encouraged to carry out rate calculations and use simple compound measures such as rate in the transpiration investigation. The effect of solute concentration on osmosis will enable learners to plot, draw and interpret appropriate graphs and to use percentiles and calculate percentage gain and loss of mass.

2.1 TRANSPORT IN CELLS

Learners should be able to:

(a) explain that diffusion is a passive process and that only certain substances pass through the cell membrane in this way

(b) explain that diffusion is the movement of substances down a concentration gradient including the use of Visking tubing as a model of living material. Explain the role of the cell membrane in diffusion

(c) explain the process of osmosis as the diffusion of water through a selectively permeable membrane, from a region of high water (low solute) concentration to a region of low water (high solute) concentration

(d) explain that active transport allows substances to enter cells against a concentration gradient and requires energy

(e) explain the need for exchange surfaces and a transport system in multicellular organisms in terms of surface area:volume ratio

(f) describe how oxygen, carbon dioxide, water, dissolved food molecules, mineral ions and urea maybe transported into and out of humans, green plants and single celled organisms

SPECIFIED PRACTICAL WORK

- SP2.1 Investigation into the effect of solute concentration on osmosis in potato chips

2.2 TRANSPORT SYSTEMS IN HUMANS

Learners should be able to:

(a) describe the human circulatory system as a double circulatory system and its relationship with the gaseous exchange system. The blood passes through the heart twice in every complete circulation. The right side of the heart pumps the blood to the lungs and the left hand side pumps it around the rest of the body

(b) label on a given diagram of the heart: the left and right atria and ventricles, semi-lunar, bicuspid and tricuspid valves, pulmonary artery, pulmonary vein, aorta and vena cava

(c) explain how the structure of the heart is adapted to its function

(d) describe the passage of blood through the heart including explaining the functions of the valves in preventing backflow of blood

(e) describe and be able to compare the structure of arteries and veins

(f) explain how arteries and veins are adapted to their functions

(g) describe that in the organs blood flows through very small blood vessels called capillaries which allow exchange of substances. Explain that the thin walls of the capillaries are an advantage for diffusion and that capillaries form extensive networks so that every cell is near to a capillary carrying blood

(h) describe the functions of the four main parts of the blood: plasma (transport of water, nutrients, hormones, urea, antibodies), red cells (carry oxygen), white cells (defence) and platelets (clotting). Explain how red blood cells, white blood cells, platelets and plasma are adapted to their functions in the blood

SPECIFIED PRACTICAL WORK

- SP2.2 Examination of artery and vein using a light microscope and production of labelled scientific drawings of these from observation

2.3 TRANSPORT SYSTEMS IN PLANTS

Learners should be able to:

(a) explain that xylem tissue contains tubes of dead cells called xylem vessels and explain how the vessels are adapted to their role in the transport of water and minerals from the roots upwards within plants

(b) explain how phloem is adapted to carry sugar from the photosynthetic areas to other parts of the plant. Sugar is moved to other parts of the plant for use in respiration and converted into starch for storage. This is called translocation

(c) explain the significance of root hairs in increasing the area for absorption, the role of osmosis in the uptake and movement of water through a plant and how mineral salts are taken up by root hairs by active transport

(d) describe the structure of a leaf and be able to label the following structures on a diagram of a T.S. leaf: cuticle, epidermis, stomata, palisade layer, spongy layer, xylem and phloem

(e) describe the structure of stomata to include guard cells and stoma and how stomata can open and close to regulate transpiration

(f) describe the process of transpiration resulting in the movement of water through a plant

(g) explain the environmental factors that can affect transpiration, including light intensity, air movement and temperature and that this can be investigated with the use of a simple potometer

3. HEALTH, DISEASE AND THE DEVELOPMENT OF MEDICINE

Overview

This topic explores the relationship between health and disease. It includes the different causes of disease, how communicable diseases can be spread and how disease can be prevented. Natural defence mechanisms are covered along with how diseases can be treated and how new medicines are developed.

Working scientifically

This topic provides many opportunities to explain every day and technological applications of science; evaluate associated personal, social, economic and environmental implications; and make decisions based on the evaluation of evidence and arguments. There are also a number of topics where learners will appreciate the power and limitations of science and consider any ethical issues which may arise. The understanding of the development of medicines will also develop the learners' skills in evaluating risks in the wider societal context, including perception of risk in relation to data and consequences. The discussion of factors influencing parental decision with regard to vaccination will also develop the skills of recognising the importance of peer review of results and of communicating results to a range of audiences. The requirement to investigate the effect of antibiotics on bacterial growth will allow all investigative skills to be developed including the selection of apparatus, interpretation of results and presenting reasoned explanations.

Mathematical skills

There are a number of opportunities for the development of mathematical skills from data which is available on the content of this topic. This could include the translation of information between graphical and numerical forms, the construction and interpretation of frequency tables and diagrams, bar charts and histograms, the use of a scatter diagram to identify a correlation between two variables. When considering health data, learners should understand the principles of sampling. Within the antibiotic investigation learners should develop their skills in geometry by calculating the cross-sectional areas of bacterial cultures and clear agar jelly using πr^2.

3.1 HEALTH AND DISEASE

Learners should be able to:

(a) describe the relationship between health and disease

(b) describe diseases as being communicable and non-communicable diseases as exemplified by influenza and cardiovascular disease

(c) describe the interactions between different types of disease, as exemplified by the increased risk of developing skin cancer when HIV positive and the increased risk of cardiovascular disease in diabetes patients

3.2 COMMUNICABLE DISEASE

Learners should be able to:

(a) explain the means by which communicable diseases caused by viruses, bacteria, protists and fungi can be spread in animals and plants. This should include by contact, aerosol, body fluids, water, insects, contaminated food.

(b) describe the following diseases, this should include the causative agent, the effect on the infected organism and how they can be prevented from spreading
- HIV/ AIDS
- Chlamydia
- Ash die back
- Malaria

(c) describe the non-specific defence systems of the human body against pathogens, including intact skin forming a barrier against microorganisms and blood clots sealing wounds to seal the skin

(d) explain the role of the immune system of the human body in defence against disease. This should include the roles of lymphocytes in secreting antibodies and antitoxins and phagocytes which ingest and digest micro-organisms. Explain the process by which antigens from micro-organisms trigger lymphocytes to release antigen specific antibodies and that antibodies activate phagocytes

(e) describe how monoclonal antibodies are produced from activated lymphocytes which are able to divide continuously. Consequently very large numbers of identical antibodies, specific to one antigen, are produced continuously in very large numbers

(f) describe some of the ways in which monoclonal antibodies can be used including:
- **diagnosis of diseases including Chlamydia and HIV**
- **tissue typing for transplants**
- **monitoring the spread of malaria**
- **supporting chemotherapy for cancers**

(g) describe the following as physical defence responses in plants forming a barrier to pathogens:
- cellulose cell walls, which may be strengthened by other chemical substances
- leaf cuticle, which forms a waxy layer on the outside of the leaf
Physical defences to herbivores include:
- specialised hardened cells
- specialised structures including stinging cells and trichomes

(h) describe chemical plant defence responses, including that many plants produce enzymes or toxic chemicals which attack insects and disease-causing bacteria and fungi

(i) describe different ways plant diseases can be detected and identified, in the lab and in the field. In the field, diseased plants can be identified by abnormal growth or by signs of the disease-causing organism, such as bacterial slime or eggs of insects. In the laboratory, pathogens can be grown on agar plates and viruses can be cultured in controlled conditions

3.3 TREATING, CURING AND PREVENTING DISEASE

Learners should be able to:

(a) explain that a vaccine contains antigens derived from a disease-causing organism. A vaccine will protect against infection by that organism by stimulating the white blood cells to produce antibodies to that antigen. Vaccines may be produced which protect against bacteria and viruses

(b) discuss the factors influencing parents in decisions about whether to have children vaccinated or not, including the need for sound scientific evidence and the effect of the media and public opinion. Understand that science can only provide a statistically based 'balance of probability' answer to such issues

(c) explain that antibiotics, including penicillin, were originally medicines produced by living organisms, such as fungi. Explain that antibiotics help to cure bacterial disease by killing the infecting bacteria or preventing their growth

(d) explain that antibiotics may kill some bacteria but not viruses. Some resistant bacteria, such as MRSA, can result from the over use of antibiotics. Explain effective control measures for MRSA

(e) explain and understand the safe use of basic aseptic techniques involved in inoculating, plating and incubating microorganisms

(f) describe the process of discovery and development of potential new medicines, including preclinical and clinical testing. New drug treatments may have side effects and extensive, large scale, rigorous testing is required including risk management. Preclinical stages involve testing on human cells grown in the laboratory, then on animals and finally a group of healthy volunteers. The new medicines are then taken for clinical testing using small groups of patients

SPECIFIED PRACTICAL WORK

- SP3.3 Investigation into the effect of antibiotics on bacterial growth

3.4 NON-COMMUNICABLE DISEASES IN HUMANS

Learners should be able to:

(a) recall that many non-communicable human diseases, including cardiovascular disease, lung cancer, skin cancer, emphysema, type 2 diabetes and cirrhosis can be caused by the interaction of a number of life style factors

(b) explain the effect of the following lifestyle factors on the incidence of non-communicable diseases at local, national and global levels: exercise, diet, alcohol, smoking and exposure to UV radiation

(c) evaluate the advantages and disadvantages of the following treatments for cardiovascular disease
- statins
- angioplasty
- changes to lifestyle diet/exercise

4. COORDINATION AND CONTROL

Overview

This topic comprises coordination and control in both humans and plants. Within the content of the nervous system in humans, reflex actions and the structure and function of the eye and parts of the brain are covered, along with some common defects of the eye and an exploration of why it is difficult to study brain function. The hormonal coordination and control in humans section contains an overview of the location of the main glands and a description of the functions of adrenalin and thyroxine. There is also detail of the function and interaction of the reproductive hormones. Homeostasis with regard to blood sugar, temperature and water regulation in humans is covered, along with the structure and function of the kidney. There is consideration of the effect of plant hormones on plant growth.

Working scientifically

The consideration of the difficulties encountered in studying the brain can lead to discussion of how scientific methods and theories develop over time and the ethical implications of studying patients with brain damage. The use of hormones in modern reproductive technology will give opportunities for explanations of technological applications of science and an evaluation of the associated personal and social implications. There is also opportunity to evaluate risk. The investigation into reaction time will allow the development of investigative skills in the cycle of collecting, presenting and analysing data.

Mathematical skills

There are a number of opportunities for the development of mathematical skills from data which is available on the content of this topic. This includes the extraction and interpretation of data from graphs, charts and tables and the translation of information between numerical and graphical forms.

4.1 NERVOUS COORDINATION AND CONTROL IN HUMANS

Learners should be able to:

(a) describe sense organs as groups of receptor cells, which respond to specific stimuli: light, sound, touch, temperature, chemicals, and then relay this information as electrical impulses along neurones to the central nervous system

(b) describe the structure of the nervous system, including the brain, spinal cord, sensory neurones, motor neurones and sensory receptors and the central nervous system consisting of the brain and spinal cord

(c) explain how the structure of the nervous system (including CNS, sensory and motor neurones and sensory receptors) is adapted to its functions

(d) describe the properties of reflex actions. These reactions are fast and automatic and some are protective, as exemplified by the withdrawal reflex, blinking and pupil size

(e) explain how the structure of a reflex arc is related to its function and be able to label a diagram to show: receptor, sensory neurone, relay neurone in spinal cord, motor neurone, effector and synapses

(f) explain the functions of the following parts of the eye: sclera, cornea, pupil, iris, lens, choroid, retina, blind spot and optic nerve recognise and be able to label these parts on a diagram of a vertical section through the eye

(g) describe common defects of the eye and explain how some of these problems may be overcome as exemplified by long-sightedness, short-sightedness and cataracts

(h) describe the structure and function of the following parts of the brain: the cerebral hemispheres, cerebellum and medulla

(i) explain that brain function is difficult to study and involves the use of brain scans, such as MRI and electrical stimulation. Discuss the ethical implications of studying patients with brain damage.

(j) explain some of the limitations in treating damage and disease in the brain and other parts of the nervous system as exemplified by Parkinson's disease and multiple sclerosis

SPECIFIED PRACTICAL WORK

- SP4.1 Investigation into factors affecting reaction times

4.2 HORMONAL COORDINATION AND CONTROL IN HUMANS

Learners should be able to:

(a) describe and be able to label the positions of the following glands on a diagram of the human body: pituitary, adrenal, thyroid, pancreas, ovaries and testes

(b) describe hormones as chemical messengers, produced by glands and carried by the blood, which control many body functions

(c) describe the principles of negative feedback mechanisms in maintaining optimum conditions inside the body

(d) explain the role of thyroxine in the body as an example of negative feedback. Description should be limited to effects of TRH and TSH in the release of thyroxine.

(e) explain the role of adrenaline in the body. Description should be limited to the effects of adrenaline on the heart, breathing and muscles. Adrenaline is converted into a less active compound by the liver.

(f) describe the roles of hormones in human reproduction, including the menstrual cycle

(g) explain the interactions of FSH, LH, oestrogen and progesterone in the control of the menstrual cycle

(h) explain the use of hormones in contraception and evaluate hormonal and non-hormonal methods of contraception

(i) explain the use of hormones in modern reproductive technologies to treat infertility

4.3 HOMEOSTASIS IN HUMANS

Learners should be able to:

(a) explain the importance to animals of maintaining a constant internal environment in response to internal and external change

(b) explain why and how glucose levels need to be kept within a constant range. When the blood glucose level rises, the pancreas releases the hormone insulin, a protein, into the blood. This causes the liver to reduce the glucose level by converting glucose to insoluble glycogen and then storing it

(c) explain how glucagon interacts with insulin to control blood sugar levels in the body

(d) compare type 1 and type 2 diabetes and explain how they can be treated. Diabetes is a common disease in which a person has a high blood sugar (glucose) level. In Type 1 diabetes this is because the body does not produce enough insulin. In Type 2 diabetes the body cells do not properly respond to the insulin that is produced

(e) describe the function of the skin in the control of body temperature. Label a diagram of a vertical section through the skin to show: hair, erector muscle, sweat gland, sweat duct, sweat pore, blood vessels. Explain the role of these structures in temperature regulation: change in diameter of blood vessels, sweating, erection of hairs; shivering as a means of generating heat

(f) describe and be able to label a diagram of the human excretory system to show kidneys, renal arteries, renal veins, aorta, vena cava, ureters, bladder, urethra and be able to indicate the direction of blood flow in the blood vessels associated with the kidney

(g) describe the function of the kidneys in maintaining the water balance of the body and remove waste products from the blood and explain why this is necessary. The waste, a solution containing urea and excess salts called urine, passes from the kidneys in the ureters to the bladder where it is stored before being passed out of the body. The presence of blood or cells in the urine indicates disease in the kidney

(h) label a section through a kidney to include: renal artery, renal vein, cortex, medulla, pelvis, ureter

(i) label a diagram of a nephron and its associated blood supply to show: capillary knot, Bowman's capsule, tubule, collecting duct, capillary network, arteriole to and from capillary knot

(j) explain the process of filtration under pressure and that selective reabsorption of glucose, some salts, and much of the water takes place in the tubule

(k) describe the effect of ADH on the permeability of the kidney tubules. The kidneys regulate the water content of the blood by producing dilute urine if there is too much water in the blood or concentrated urine if there is a shortage of water in the blood. ADH increases the permeability of the collecting duct walls to water. More ADH is produced if there is a shortage of water in the blood, more water is reabsorbed and so a more concentrated urine is produced

(l) explain the effect on cells of osmotic changes in body fluids

(m) explain the response of the body to different temperature and osmotic challenges

SPECIFIED PRACTICAL WORK

- SP4.3 Dissection of mammalian kidney

4.4 PLANT HORMONES

Learners should be able to:

(a) explain how auxins are important in the control and coordination of plant growth and development, including the positive response of plant shoots to light, phototropism, and plant roots to gravity, gravitropism

(b) describe some of the effects of plant hormones, relating to auxins, **gibberellins** and **ethene**

(c) describe some of the different ways in which people use plant hormones to control plant growth

5. PHOTOSYNTHESIS

Overview

Life on Earth is dependent on photosynthesis in which green plants and algae trap light from the Sun to fix carbon dioxide and combine it with hydrogen from water to make organic compounds and oxygen. This topic covers the process of photosynthesis and factors which affect the rate of photosynthesis.

Working scientifically

The investigation into factors affecting the rate of photosynthesis allows many skills to be developed. These include: the use of scientific theories to develop hypotheses; the planning experiments to make observations and test hypotheses; selection of apparatus; carrying out of experiments having due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations; making and recording observations and measurements using a range of apparatus and methods; evaluating methods and suggesting possible improvements and further investigations.

Mathematical skills

There are a number of opportunities for the development of mathematical skills within the investigation. These skills include the understanding and use of simple compound measures such as the rate of a reaction; translating information between graphical and numerical form; plotting and drawing appropriate graphs, selecting appropriate scales for axes; extracting and interpreting information from graphs, charts and tables. **Higher tier learners should be able to understand and use inverse proportion – the inverse square law and light intensity in the context of factors affecting photosynthesis**

Learners should be able to:

(a) describe the process of photosynthesis and describe photosynthesis as an endothermic reaction, whereby green plants and other photosynthetic organisms use chlorophyll and light to convert carbon dioxide and water into glucose, producing oxygen as a by-product. Recall the word equation for photosynthesis

(b) explain the effect of temperature, light intensity and carbon dioxide concentration on the rate of photosynthesis

(c) explain the interaction of these factors in limiting the rate of photosynthesis

SPECIFIED PRACTICAL WORK

- SP5 Investigation into factors affecting the rate of photosynthesis

6. ECOSYSTEMS

Overview

Living organisms may form populations of single species, communities of many species and ecosystems, interacting with each other, with the environment and with humans in many different ways. The chemicals within these ecosystems are continually cycling through the natural world. This topic comprises coverage of the levels of organisation within an ecosystem, the principles of material cycling, biodiversity and sustainability. Opportunities are given to look in detail at the factors affecting communities and how the numbers of organisms and biomass within each level can be represented. The carbon cycle and water cycle are covered in material cycling, along with how human activity affects them. Learners need to acquire an understanding of the importance of biodiversity and how it can be measured. The need to balance human requirements with biodiversity is also covered.

Working scientifically

The topics discussing the benefits and challenges of maintaining local and global biodiversity will allow learners to develop skills in evaluating social, economic and environmental applications based on the evaluation of evidence and arguments. The sections on biological control and genetic modifications would allow learners to evaluate risks in the wider societal context, including perception of risk in relation to consequences. There are also a number of opportunities to develop skills in analysis and evaluation within the investigations into factors affecting decomposition and the abundance and distribution of a species. These would include: presentation of data, translating data from one form to another; carrying out and representing mathematical and statistical analysis; representing distributions of results and making estimations of uncertainty and communicating the methods used, findings and conclusions through written or electronic reports. Learners should also be able to apply sampling techniques within the fieldwork to any ensure any samples collected are representative.

Mathematical skills

There are a number of opportunities for the development of mathematical skills within the investigations in this topic. These would include the calculation of rate changes in the decay of biological material, the calculation of the percentage of mass, the calculation of arithmetic means, being able to use percentages and fractions, plotting and drawing appropriate graphs and selecting appropriate scales for the axes and extracting and interpreting information from charts, graphs and tables.

6.1 LEVELS OF ORGANISATION WITHIN AN ECOSYSTEM

Learners should be able to:

(a) describe different levels of organisation in an ecosystem from individual organisms through populations and communities to the whole ecosystem

(b) explain how some abiotic factors affect communities as exemplified by pH, light, temperature and salinity

(c) explain how some biotic factors affect communities as exemplified by predation, disease and food availability

(d) describe the importance of interdependence and competition in a community

(e) describe photosynthetic organisms as the main producers of food and therefore biomass for life on Earth. Green plants, and other photosynthetic organisms such as algae use the light from the sun to produce organic materials

(f) describe the differences between the trophic levels of organisms within an ecosystem including producers; first, second and third stage consumers; herbivores and carnivores

(g) investigate data about food chains and food webs and explain that they show the transfer of biomass between organisms

(h) use data to construct and interpret pyramids of numbers

(i) describe pyramids of biomass and explain, with examples, how biomass is lost between the different trophic levels. At each stage in the food chain biomass is used in repair and in the maintenance and growth of cells whilst biomass is lost in waste materials and respiration which is exothermic

(j) calculate the efficiency of biomass transfers between trophic levels and explain how this affects the number of organisms at each trophic level

6.2 THE PRINCIPLE OF MATERIAL CYCLING

Learners should be able to:

(a) recall that many different materials cycle through the abiotic and biotic components of an ecosystem. Nutrients are released in decay, e.g. nitrates and phosphates and these nutrients are then taken up by other organisms resulting in nutrient cycles. In a stable community the processes which remove materials are balanced by processes which return materials

(b) explain why it is important that carbon is constantly cycled in nature by the carbon cycle via photosynthesis which incorporates it and respiration which releases it

(c) explain that microorganisms, bacteria and fungi, feed on waste materials from organisms and that when plants and animals die their bodies are broken down by microorganisms bringing about decay. These micro-organisms respire and release carbon dioxide into the atmosphere. Burning fossil fuels releases carbon dioxide

(d) explain the importance the water cycle to living organisms

(e) explain the effects of factors such as temperature and water content on rate of decomposition in aerobic and anaerobic environments

(f) evaluate the evidence for the impact of environmental changes on the distribution of organisms, with reference to water and atmospheric gases

SPECIFIED PRACTICAL WORK

- SP6.2 Investigation into factors affecting decomposition

6.3 BIODIVERSITY

Learners should be able to:

(a) describe how to use quadrats to investigate the abundance of species e.g. a comparison of different sides of a hedge or mown and unmown grassland

(b) describe how transects can be used to measure changes in the abundance and distribution of species e.g. seashore

(c) describe the principles of sampling, the need to collect sufficient data and use of appropriate statistical analysis. (Details of statistical tests are not required.) Describe the principles of capture/recapture techniques including simple calculations on estimated population size

(d) explain what is meant by biodiversity, the variety and number of different species in an area, and why it is important. Explain that indicator species are an important set of organisms whose numbers and changing population can tell us a lot about the changing state of ecosystems

(e) describe both positive and negative human interactions within ecosystems and explain their impact on biodiversity

(f) describe the ways in which biodiversity and endangered species can be protected locally and globally, including issues surrounding the use of legislation. Explain the need for and issues associated with the collection of reliable data and ongoing environmental monitoring

(g) explain the use of biological control agents and the introduction of alien species and their effects on local wildlife. Explain the issues surrounding the use of biological control agents and how the approach to using this method of control has changed as requirements for detailed research and scientifically based trials and analysis are now more fully understood

(h) explain some of the benefits and challenges of maintaining local and global biodiversity

SPECIFIED PRACTICAL WORK

- SP6.3 Investigation into factors affecting the abundance and distribution of a species

6.4 SOME OF THE BIOLOGICAL CHALLENGES OF INCREASING FOOD YIELDS USING FEWER RESOURCES

Learners should be able to:

(a) describe the issues surrounding the need to balance the human requirements for food and economic development with the needs of wildlife. Discuss how the collection of detailed, reliable scientific information and monitoring by biologists could help to inform, manage and reduce the impact of development on the environment e.g. the role of the Environment Agency

(b) describe some of the biological factors affecting levels of food security including increasing human population, changing diets in wealthier populations, new pests and pathogens, environmental change, sustainability and cost of agricultural inputs

(c) describe and explain some possible biotechnological and agricultural solutions, including genetic modification, to the demands of the growing human population

7. INHERITANCE, VARIATION AND EVOLUTION

Overview

The characteristics of a living organism are influenced by its genome and its interaction with the environment. Living organisms are interdependent and show adaptations to their environment. These adaptations are a result of evolution. Evolution occurs by a process of natural selection and accounts both for biodiversity and how organisms are all related to varying degrees. Coverage of the genome and gene expression requires that learners understand how DNA controls protein synthesis within the cell and so contributes, along with environmental factors towards the characteristics that an organism shows. The understanding of the genome has vast implications for the medicine of the future. The topic of inheritance covers an understanding of how characteristics are passed on, along with an understanding of how that knowledge has been developed. Learners will acquire an understanding of evolution and how it has resulted in the biodiversity seen on Earth.

Working scientifically

The discussion of the potential for the human genome gives opportunities to explain the technological applications of science and also to evaluate the risks and ethics of such information being more widely available. The study of the work of Gregor Mendel, Charles Darwin and Alfred Wallace allows learners to understand how scientific theories develop over time and also the importance of peer review and communicating results. The study of the development of classification systems also contributes towards this.

Mathematical skills

There are a number of opportunities for the development of mathematical skills within this topic. These include being able to understand and use direct proportions and simple ratios in the study of genetic crosses, understanding and using the concept of probability in predicting the outcome of genetic crosses and extracting and interpreting information from charts, graphs and tables.

7.1 THE GENOME AND GENE EXPRESSION

Learners should be able to:

(a) describe chromosomes as linear arrangements of genes. Chromosomes that are found in pairs in body cells are strands of DNA

(b) describe DNA as a polymer made up of two strands forming a double helix

(c) describe DNA as a polymer made from four different nucleotides; each nucleotide consisting of a common sugar and phosphate group with one of four different bases attached to the sugar

(d) **recall a simple description of protein synthesis. There are four bases, A, T, C and G within DNA and that it is the order of these bases which forms a code to produce proteins**

(e) **explain simply how the structure of DNA affects the proteins made in protein synthesis. There is complementary base pairing between adenine and thymine, cytosine and guanine. The order of bases determines the order in which different amino acids are linked together to form different proteins. The bases are read in groups of three, this is called the triplet code**

(f) **describe how the genes for a particular protein may occur in different forms (alleles or variants) which have different sequences of bases in their DNA. These variants, therefore, will give rise to differences in the order of amino acids in the protein and change its activity, affecting a characteristic of an organism**

(g) **describe that a large amount of DNA does not occur in genes and the bases do not form part of the genetic code for producing proteins. Instead, this non-coding DNA coordinates and controls how and when particular genes become active and produce proteins**

(h) describe how an organism's DNA can be analysed by 'genetic profiling' and how this can be used to show the similarity between two DNA samples. The process involves cutting the DNA into short pieces which are then separated into bands. The pattern of the bands produced can be compared to show the similarity between two DNA samples

(i) describe the genome as the entire genetic material of an organism

(j) discuss the potential importance for medicine of our increasing understanding of the human genome

SPECIFIED PRACTICAL WORK

- SP7.1 Simple extraction of DNA from living material

7.2 INHERITANCE

Learners should be able to:

(a) explain the following terms: gamete, chromosome, gene, allele/variant, dominant, recessive, homozygous, heterozygous, genotype phenotype

(b) describe genes as sections of DNA molecules that determine inherited characteristics and that are in pairs. Genes have different forms, called alleles

(c) explain single gene inheritance and be able to complete Punnett squares to show this

(d) predict the outcomes of monohybrid crosses including ratios

(e) recall that most phenotypic features are the result of multiple genes rather than single gene inheritance

(f) describe sex determination in humans. In human body cells, one of the pairs of chromosomes, XX or XY, carries the genes which determine sex. These separate and combine randomly at fertilisation

(g) describe the development of our understanding of genetics including the work of Gregor Mendel. Discuss why the significance of his work was not recognised and validated by scientists for many years

7.3 VARIATION AND EVOLUTION

Learners should be able to:

(a) explain some of the advantages and disadvantages of asexual and sexual reproduction in a range of organisms

(b) describe simply how the genome, and its interaction with the environment, influence the development of the phenotype of an organism. Variation may be due to environmental or genetic causes or a combination of the two

(c) state that there is usually extensive genetic variation within a population of a species

(d) recall that all variants result from changes, mutations, in existing genes and that mutations occur at random. Most mutations have no effect on the phenotype but some influence phenotype and very few determine phenotype. Mutation rates can be increased by ionising radiation

(e) describe evolution as a change in the inherited characteristics of a population over time through a process of natural selection which may result in the formation of new species. Genes which enable better adapted individuals to survive are passed on to the next generation. This may results in new species being formed. The process of natural selection is sometimes too slow for organisms to adapt to new environmental conditions and so organisms may become extinct

(f) explain how individuals with characteristics adapted to their environment are more likely to survive and breed successfully. This results in evolution

(g) describe that evolution is ongoing as shown by the development of resistance to antimicrobial chemicals by bacteria or Warfarin resistance in rats and that evolution can also be evidenced by fossils

(h) describe the impact of developments in biology on classification systems; biological classification systems continue to be modified in the light of ongoing research. Recently, the three Domain system (based on differences in RNA) proposes two Domains of prokaryotes and one further Domain containing four main eukaryote kingdoms – Protists, Fungi, Plants and Animals

(i) describe the work of Darwin and Wallace in the development of the theory of evolution by natural selection and explain the impact of these ideas on modern biology

7.4 SELECTIVE BREEDING AND GENE TECHNOLOGY

Learners should be able to:

(a) explain the impact of the selective breeding of food plants and domesticated animals

(b) describe genetic engineering as a process which involves modifying the genome of an organism to introduce desirable characteristics

(c) describe the main steps in the process of genetic engineering

(d) explain some of the possible benefits and risks, including practical and ethical considerations, of using gene technology in modern agriculture and medicine

2.2 Component 2

APPLICATIONS IN BIOLOGY

Written examination: 1 hour 15 minutes
25% of qualification
60 marks

This component will assess the skills of learners in the context of the content of Component 1.

The assessment of this component will comprise two sections.

Section A Foundation Tier / Section B Higher Tier (45 marks)
This will contain a mix of short answer questions, structured questions, extended writing and data response questions, all set in a practical context. Some of the questions will be based on specified practical work whilst others will be set in a novel context.

Section B Foundation Tier / Section A Higher Tier (15 marks)
A resource booklet containing an unseen article will provide the basis for a mix of short answer questions, structured question and data response questions.

3 ASSESSMENT

3.1 Assessment objectives and weightings

Below are the assessment objectives for this specification. Learners must:

AO1
Demonstrate knowledge and understanding of:

- scientific ideas
- scientific techniques and procedures

AO2
Apply knowledge and understanding of:

- scientific ideas
- scientific enquiry, techniques and procedures

AO3
Analyse information and ideas to:

- interpret and evaluate
- make judgements and draw conclusions
- develop and improve experimental procedures

The table below shows the weighting of each assessment objective for each component and for the qualification as a whole.

	AO1	**AO2**	**AO3**
Component 1	30%	30%	15%
Component 2	10%	10%	5%
Overall weighting	**40%**	**40%**	**20%**

For each series:

- The weighting for the assessment of mathematical skills will be a minimum of 10%
- The weighting for the assessment of practical skills will be a minimum of 15%

Learners will be expected to provide extended responses which are of sufficient length to allow them to demonstrate their ability to construct and develop a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.

3.2 Arrangements for practical work

The assessment of practical skills is a compulsory requirement of the course of study for GCSE Biology qualifications.

The content includes specified practical work that must be undertaken by learners in order that they are suitably prepared for the written examinations. The completion of this practical work will develop the skills listed in Appendix A.

In addition, by completing the specified practical work learners will experience each of the practical techniques listed in Appendix B which are a requirement of the qualification. Centres must also ensure that learners keep their own records of the practical work that they undertake.

When completing any practical work safety is of paramount concern. It is the responsibility of each centre to ensure that appropriate safety procedures are followed whenever their learners' complete practical work. Risk assessments are required for all practical work whether it takes place in the laboratory or out in the field.

For each assessment series each centre is required to submit a practical science statement (see Appendix D) to WJEC. The statement is confirmation from a centre that it has taken reasonable steps to ensure that each learner entered for that particular assessment series has completed the practical work listed in the specification. Also the centre has made a record of the specified practical work that each learner has undertaken and the knowledge, skills and understanding that the learner has derived from the completion of the practical work. The practical science statement must be submitted to WJEC for learners in a particular cohort before the awarding of their GCSE. This will be on a date published by WJEC and will fall before the end of May.

If a centre fails to submit a practical science statement to WJEC for an assessment series then it will be treated as a case of malpractice and/or maladministration.

Centres must have systems in place that enable them to ensure that private learners have completed the required specified practical work. It will be the responsibility of the centre entering private learners to validate that these learners have covered the full range of practical requirements described in the specification.

4 TECHNICAL INFORMATION

4.1 Making entries

This is a linear qualification in which all assessments must be taken at the end of the course. Candidates entered for this qualification must sit both components at either foundation or higher tier, in the same examination series. Assessment opportunities will be available in May/June each year, until summer 2020, with a resit opportunity in summer 2021.

A qualification may be taken more than once. Candidates must resit all examination components in the same series.

The entry codes appear below.

WJEC Eduqas GCSE Biology (Foundation tier):	C400PF
WJEC Eduqas GCSE Biology (Higher tier):	C400PH

The current edition of our *Entry Procedures and Coding Information* gives up-to-date entry procedures.

4.2 Grading, awarding and reporting

GCSE qualifications are reported on a nine point scale from 1 to 9, where 9 is the highest grade. Results not attaining the minimum standard for the award will be reported as U (unclassified).

A candidate who takes higher tier assessments will be awarded a grade within the range of 4 to 9, or be unclassified. However, if the mark achieved by such a learner is a small number of marks below the 4/3 grade boundary that learner may be awarded a grade 3.

A candidate who takes foundation tier assessments will be awarded a grade within the range of 1 to 5, or be unclassified.

APPENDIX A

Working scientifically

1. Development of scientific thinking

- understand how scientific methods and theories develop over time
- use a variety of models such as representational, spatial, descriptive, computational and mathematical to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts
- appreciate the power and limitations of science and consider any ethical issues which may arise
- explain every day and technological applications of science; evaluate associated personal, social, economic and environmental implications; and make decisions based on the evaluation of evidence and arguments
- evaluate risks both in practical science and the wider societal context, including perception of risk in relation to data and consequences
- recognise the importance of peer review of results and of communicating results to a range of audiences.

2. Experimental skills and strategies

- use scientific theories and explanations to develop hypotheses
- plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena
- apply a knowledge of a range of techniques, instruments, apparatus, and materials to select those appropriate to the experiment
- carry out experiments appropriately having due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations
- recognise when to apply a knowledge of sampling techniques to ensure any samples collected are representative
- make and record observations and measurements using a range of apparatus and methods
- evaluate methods and suggest possible improvements and further investigations.

3. Analysis and evaluation

- apply the cycle of collecting, presenting and analysing data, including:
    - presenting observations and other data using appropriate methods
    - translating data from one form to another
    - carrying out and represent mathematical and statistical analysis
    - representing distributions of results and make estimations of uncertainty
    - interpreting observations and other data (presented in verbal, diagrammatic, graphical, symbolic or numerical form), including identifying patterns and trends, making inferences and drawing conclusions
    - presenting reasoned explanations including relating data to hypotheses
    - being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error
    - communicating the scientific rationale for investigations, methods used, findings and reasoned conclusions through paper-based and electronic reports and presentations using verbal, diagrammatic, graphical, numerical and symbolic forms.

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

- use scientific vocabulary, terminology and definitions
- recognise the importance of scientific quantities and understand how they are determined
- use SI units (e.g. kg, g, mg; km, m, mm; kJ, J) and IUPAC chemical nomenclature unless inappropriate
- use prefixes and powers of ten for orders of magnitude (e.g. tera, giga, mega, kilo, centi, milli, micro and nano)
- interconvert units
- use an appropriate number of significant figures in calculation.

APPENDIX B

Practical requirements and exemplification

All learners are expected to have carried out the **specified practical activities**. These develop skills in the use of the following apparatus and techniques.
The apparatus and techniques listed as 1 – 7 below are common with GCSE Combined Science. Statement 8 is for GCSE Biology only.

code	Practical technique
B1	Use of appropriate apparatus to make and record a range of measurements accurately, including length, area, mass, time, temperature, volume of liquids and gases, and pH
B2	Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater
B3	Use of appropriate apparatus and techniques for the observation and measurement of biological changes and/or processes
B4	Safe and ethical use of living organisms (plants or animals) to measure physiological functions and responses to the environment
B5	Measurement of rates of reaction by a variety of methods including production of gas, uptake of water and colour change of indicator
B6	Application of appropriate sampling techniques to investigate the distribution and abundance of organisms in an ecosystem via direct use in the field
B7	Use of appropriate apparatus, techniques and magnification, including microscopes, to make observations of biological specimens and produce labelled scientific drawings
B8	Use of appropriate techniques and qualitative reagents to identify biological molecules and processes in more complex and problem-solving contexts including continuous sampling in an investigation.

The list on the following page cross references the specified practical work against the apparatus and skills listed above. These include opportunities for choice and use of appropriate laboratory apparatus for a variety of experimental problem-solving and/or enquiry based activities.

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

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

Specified practical work	Specification topic	Technique code
SP1.1 Examination of plant and animal cells using a light microscope and production of labelled scientific drawings from observation.	1.1	B3, B4, B7
SP1.3A Investigation into factors affecting enzyme action	1.3	B1, B2, B3, B4, B5, B8
SP1.3B Qualitative identification of starch (iodine), glucose (Benedict's) and protein (biuret)	1.3	B2, B3, B8
SP2.1 Investigation into the effect of solute concentration on osmosis in potato chips	2.1	B1, B3, B4, B5
SP2.2 Examination of artery and vein using a light microscope and production of labelled scientific drawings of these from observation	2.2	B3, B7
SP3.3 Investigation into the effect of antibiotics on bacterial growth	3.3	B1, B3, B4, B5
SP4.3 Dissection of mammalian kidney	4.3	B3, B4, B7
SP4.1 Investigation into factors affecting reaction times	4.1	B1, B3, B4, B5
SP5 Investigation into factors affecting the rate of photosynthesis	5.1	B1, B2, B3, B4, B5
SP6.2 Investigation into factors affecting decomposition	6.2	B1, B3, B4
SP6.3 Investigation into factors affecting the abundance and distribution of a species	6.3	B1, B3, B4, B6
SP7.1 Simple extraction of DNA from living material	7.1	B2, B3, B4

Learners are expected to cover the **full** range of practical techniques using the specified practical work. WJEC will publish teacher/technician guidance sheets and learner worksheets for all the specified practical work which centres may use with their learners. These will ensure that all the techniques referred to in the above table are met. Centres may substitute the exemplar specified practical for another one of comparable standard. In such cases the same techniques cross referenced in the above **must** also be covered by the substituted practical. Learners **must** also be familiar with the same set of skills in this practical as required by the exemplar practical.

Centres should also note that WJEC will:

- review the specified practical work which it has set following any revision by the Secretary of State of the apparatus and/or techniques specified in respect of the qualification
- revise the specified practical work which it has set if appropriate
- promptly publish an amended specification if it makes any revision to the practical work.

APPENDIX C

Mathematical skills

This table shows the mathematical skills which can be assessed.

	Mathematical skill
1	**Arithmetic and numerical computation**
a	Recognise and use expressions in decimal form
b	Recognise and use expressions in standard form
c	Use ratios, fractions and percentages
d	Make estimates of the results of simple calculations
2	**Handling data**
a	Use an appropriate number of significant figures
b	Find arithmetic means
c	Construct and interpret frequency tables and diagrams, bar charts and histograms
d	Understand the principles of sampling as applied to scientific data
e	Understand simple probability
f	Understand the terms mean, mode and median
g	Use a scatter diagram to identify a correlation between two variables
h	Make order of magnitude calculations
3	**Algebra**
a	Understand and use the symbols: =, <, <<, >>, >, ∝, ~
d	Solve simple algebraic equations
4	**Graphs**
a	Translate information between graphical and numeric form
b	Understand that $y = mx+c$ represents a linear relationship
c	Plot two variables from experimental or other data
d	Determine the slope and intercept of a linear graph
5	**Geometry and trigonometry**
c	Calculate areas of triangles and rectangles, surface areas and volumes of cubes.

Please note. Only mathematical skills required for GCSE Biology are shown in the table above.

APPENDIX D

Practical science statement

Practical Science Statement
GCSE Biology

Centre Name .....

Centre Number .....

Declaration by head of centre
I confirm that: 1. *This centre has taken reasonable steps to ensure that each learner entered for assessment in this summer series has completed the specified practical work listed in the specification and they have kept a record of their work;* 2. *This centre has made a record of the specified practical work that each learner has undertaken and the knowledge, skills and understanding that the learner has derived from the completion of the practical work.* ***Head of centre's name**: .....* ***Head of centre's signature**: ..... Date .....*

Summer 20....