GCE AS

eduqas
Part of WJEC

WJEC Eduqas GCE AS in

BIOLOGY

ACCREDITED BY OFQUAL

SPECIFICATION

Teaching from 2015
For award from 2016

wjec cbac

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

WJEC Eduqas GCE AS in BIOLOGY

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AS BIOLOGY

SUMMARY OF ASSESSMENT

Component 1: Basic Biochemistry and Cell Organisation
Written examination: **1 hour 30 minutes**
50% of qualification
75 marks

A range of short and longer structured compulsory questions.

Component 2:
Biodiversity and Physiology of Body Systems
Written examination: **1 hour 30 minutes**
50% of qualification
75 marks

A range of short and longer structured compulsory questions.

This linear qualification will be available in the months of May/June each year. It will be awarded for the first time in Summer 2016.

Qualification Accreditation Number: 601/5705/7

AS BIOLOGY

1 INTRODUCTION

1.1 Aims and objectives

The WJEC Eduqas AS in Biology provides a wide breadth of knowledge which touches on many varied aspects of a range of topics. These include the internal workings of organisms in physiology and the interdependence of living things in ecology, to social issues including human influence on the environment and the ethical considerations of genetics.

The study of biology encourages an appreciation of these issues and their implications as well as providing an insight into the living world.

This specification promotes an understanding of scientific method as the means to increase knowledge and to develop an enquiring and critical approach. Learners will develop an awareness that different perceptions, predictions and interpretations may be applied according to context.

Practical work is an intrinsic part of biology, and is greatly valued by higher education. It is imperative that practical skills are developed throughout this course and that an investigative approach is promoted.

It is intended that the use of a variety of approaches will stimulate interest, promote understanding and engender an overall appreciation and sense of wonder at the living world.

The WJEC Eduqas AS in Biology aims to encourage learners to:

- develop essential knowledge and understanding of different areas of biology and how they relate to each other
- develop and demonstrate a deep appreciation of the skills, knowledge and understanding of scientific methods used within biology
- develop competence and confidence in a variety of practical, mathematical and problem solving skills
- develop their interest in and enthusiasm for biology, including developing an interest in further study and careers associated with the subject
- understand how society makes decisions about biological issues and how biology contributes to the success of the economy and society.

1.2 Prior learning and progression

Any requirements set for entry to a course following this specification are at the discretion of centres. It is reasonable to assume that many learners will have achieved qualifications equivalent to Level 2 at KS4. Skills in Numeracy/Mathematics, Literacy/English and Information Communication Technology will provide a good basis for progression to this qualification.

This specification builds on the skills, knowledge and understanding set out in the GCSE criteria/content for science. Some learners will have already gained knowledge, understanding and skills through their study of biology at GCSE.

Mathematical requirements are specified in the subject criteria and repeated in Appendix B of this specification.

This specification provides a suitable foundation for the study of biology at A level. 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.

This specification is not age specific and, as such, provides opportunities for candidates to extend their life-long learning.

1.3 Equality and fair assessment

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, Reasonable Adjustments and Special Consideration: 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 AS 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 are requirements of all ASl specifications. In practice, this means that questions set in any AS component may require learners to demonstrate their ability to draw together different areas of knowledge 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 biology. The practical skills developed are also fundamentally important to learners going on to further study in biology 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 practical skills listed in Appendix A.

Appendix B lists the mathematical requirements with exemplification in the context of AS Biology.

Each topic area includes an overview outlining the content and how it contributes to the wider aims of the specification. Knowledge of specific contexts and/or examples included in the overview will not be directly assessed.

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

- use theories, models and ideas to develop scientific explanations
- use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas
- use appropriate methodology, including information and communication technology (ICT), to answer scientific questions and solve scientific problems
- carry out experimental and investigative activities, including appropriate risk management, in a range of contexts
- analyse and interpret data to provide evidence, recognising correlations and causal relationships
- evaluate methodology, evidence and data, and resolve conflicting evidence

- know that scientific knowledge and understanding develops over time
- communicate information and ideas in appropriate ways using appropriate terminology
- consider applications and implications of science and evaluate their associated benefits and risks
- consider ethical issues in the treatment of humans, other organisms and the environment
- evaluate the role of the scientific community in validating new knowledge and ensuring integrity
- evaluate the ways in which society uses science to inform decision making.

Appendix C exemplifies the areas of the specification where these skills can be developed.

2.1 Component 1

BASIC BIOCHEMISTRY AND CELL ORGANISATION

Written examination: 1 hour 30 minutes
50% of qualification

This component includes the following topics:

1. Chemical elements are joined together to form biological compounds
2. Cell structure and organisation
3. Cell membranes and transport
4. Biological reactions are regulated by enzymes
5. Nucleic acids and their functions
6. Genetic information is copied and passed on to daughter cells

Basic Biochemistry and Cell Organisation

1. Chemical elements are joined together to form biological compounds

Overview
All organisms are composed of biological molecules. These are fundamental to the functioning of living organisms. It is essential to understand how the structure of these molecules is related to their function.

Working scientifically
This topic contains a number of opportunities to use qualitative reagents to identify biological molecules. These skills can be further used to develop independent thinking in identifying unknown compounds.

Mathematical Skills
There are a number of mathematical skills that could be developed using data from this topic. These include making use of appropriate units; using ratios, fractions and percentages; construction and interpretation of tables and diagrams; using scatter diagrams to identify a correlation.

How Science Works
There are opportunities within this topic for learners to develop the ability to: use theories, models and ideas to develop scientific explanations in considering the structure of the biological molecules and communicate this information and ideas in appropriate ways using appropriate terminology. The practical work will allow learners to: carry out experimental and investigative activities, including appropriate risk assessments; use appropriate methodology, including information and communication technology (ICT) to answer scientific questions and solve scientific problems. The consideration of the evidence of the implications of saturated and unsaturated fat gives opportunity to: consider applications and implications of science and evaluate their associated benefits and risks; evaluate the role of the scientific community in validating new knowledge and ensuring integrity; evaluate the ways in which society uses science to inform decision making.

Learners should be able to demonstrate and apply their knowledge and understanding of:

(a) the key elements present as inorganic ions in living organisms: Mg^{2+}, Fe^{2+}, Ca^{2+}, PO_4^{3-}

(b) the importance of water in terms of its polarity, ability to form hydrogen bonds, surface tension, as a solvent, thermal properties, as a metabolite

(c) the structure, properties and functions of carbohydrates: monosaccharides (triose, pentose, hexose sugars); disaccharides (sucrose, lactose, maltose); polysaccharides (starch, glycogen, cellulose, chitin)

(d) alpha and beta structural isomerism in glucose and its polymerisation into storage and structural carbohydrates, illustrated by starch, cellulose and chitin

(e) the chemical and physical properties which enable the use of starch and glycogen for storage and cellulose and chitin as structural compounds

(f) the structure, properties and functions of lipids as illustrated by triglycerides and phospholipids

(g) the implications of saturated and unsaturated fat on human health

(h) the structure and role of amino acids and proteins

(i) the primary, secondary, tertiary and quaternary structure of proteins

(j) the relationship of the fibrous and globular structure of proteins to their function

Learners should be able to use given structural formulae (proteins, triglycerides and carbohydrates) to show how bonds are formed and broken by condensation and hydrolysis, including peptide, glycosidic and ester bonds.
(Learners should be able to recognise and understand but not reproduce the structural formulae of the above molecules.)

SPECIFIED PRACTICAL WORK

- Food tests to include: iodine-potassium iodide test for starch; Benedict's test for reducing and non-reducing sugars; Biuret test for protein; emulsion test for fats and oils

Basic Biochemistry and Cell Organisation

2. Cell structure and organisation

Overview
All organisms are composed of cells. Cell theory is a unifying concept in biology. The theory states that new cells are formed from other existing cells, and that the cell is a fundamental unit of structure, function and organisation in all living organisms. The understanding of the ultrastructure of cells has been developed through advances in microscopy.

Working scientifically
This topic gives learners opportunities to develop skills in light microscopy, observation and scientific drawing and interpreting electron micrographs.

Mathematical Skills
There are a number of opportunities for the development of mathematical skills especially within the microscope work in this topic. These include making use of appropriate units; calculating and using ratios, fractions and percentages; using an appropriate number of significant figures and decimal places; making order of magnitude calculations; changing the subject of an equation; substitution of numerical values into algebraic equations.

How Science Works
The consideration of cell theory within this topic allows learners to consider that scientific knowledge and understanding develop over time and to evaluate the role of the scientific community in validating new knowledge and ensuring integrity. Understanding the ultrastructure of the cell allows learners to: use theories, models and ideas to develop scientific explanations; use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas and communicate information and ideas in appropriate ways using appropriate terminology. The microscope work allows learners to carry out experimental and investigative activities, including appropriate risk assessments.

Learners should be able to demonstrate and apply their knowledge and understanding of:

(a) the structure and function of the following: mitochondria; endoplasmic reticulum (rough and smooth); ribosomes; Golgi body; lysosomes; centrioles; chloroplasts; vacuoles; nucleus; chromatin; nuclear envelope; nucleolus; plasmodesmata

(b) the structure of prokaryotic cells and viruses

(c) cell theory and the similarities and differences in the cell structures of eukaryotes(animal and plant) and prokaryotes and of viruses, including the examination of a range of electron micrographs of prokaryote and eukaryote cells to show structure

(d) the levels of organisation including aggregation of cells into tissues, tissues into organs and organs into organ systems and also the examination of a range of prepared slides showing examples of epithelia, muscle and connective tissue

SPECIFIED PRACTICAL WORK

- Calibration of the light microscope at low and high power, including calculation of actual size of a structure and the magnification of a structure in a drawing
- Preparation and scientific drawing of a slide of living cells e.g. onion/ rhubarb/ *Amoeba* including calculation of actual size and magnification of drawing

:Basic Biochemistry and Cell Organisation

3. Cell membranes and transport

Overview
Cell membranes are essential in the control of the movement of substances into and out of the cell. They also play a vital role in cell recognition.

Working scientifically
This topic gives learners opportunities to develop skills in investigative techniques, using appropriate apparatus to record quantitative measurements, including mass and length, in the determination of water potential. There is also the opportunity to use appropriate instrumentation such as a colorimeter when investigating factors affecting permeability of cell membranes of beetroot. Microscope techniques can be developed when measuring incipient plasmolysis.

Mathematical Skills
There are a number of opportunities for the development of mathematical skills especially within the specified practical work in this topic. These include the use of units, ratios, fractions and percentages; use of standard and decimal form; finding arithmetic means; estimating results; using significant figures; construction and interpretation of tables and diagrams; using mean, median and mode; use of standard deviation; identifying uncertainties in measurements; plotting variables from experimental data; understanding that $y= mx + c$ represents a linear relationship; calculating a rate of change from a graph showing a linear relationship; drawing and using the slope of a tangent to a curve as a measure of rate of change. In determining water potentials and solute potentials learners can develop the ability to solve algebraic equations. There is also opportunity using data from the topic to: calculate surface areas and volumes; use scatter diagrams; translate information between graphical, numerical and algebraic forms.

How Science Works
There are opportunities within this topic for learners to develop the ability to: use theories, models and ideas to develop scientific explanations in the understanding of the structure of the fluid mosaic model of the plasma membrane. Within the practical work and understanding of transport mechanisms there are opportunities to: use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas; carry out experimental and investigative activities, including appropriate risk assessments; evaluate methodology, evidence and data, and resolve conflicting evidence; communicate information and ideas in appropriate ways using appropriate terminology.

Learners should be able to demonstrate and apply their knowledge and understanding of:

(a) the principal components of the plasma membrane and understand the fluid-mosaic model

(b) the factors affecting permeability of the plasma membrane

(c) the following transport mechanisms: diffusion and factors affecting the rate of diffusion; osmosis and water potential; pinocytosis; facilitated diffusion; phagocytosis; secretion (exocytosis); active transport and the influence of cyanide

SPECIFIED PRACTICAL WORK

- Determination of water potential by measuring changes in mass or length
- Determination of solute potential by measuring the degree of incipient plasmolysis
- Investigation into the permeability of cell membranes using beetroot

Basic Biochemistry and Cell Organisation

4. Biological reactions are regulated by enzymes

Overview
Enzymes are vital in controlling metabolism in organisms. Scientists' knowledge of their structure and function has enabled enzymes to be used extensively in industry.

Working scientifically
The enzyme investigations in this topic give learners opportunities to develop skills in investigative technique, using appropriate apparatus to record quantitative measurements, including temperature and pH and using laboratory apparatus to produce serial dilutions. There are also opportunities to use ICT such as computer modelling, or a data logger to collect data, or software to process data.

Mathematical Skills
There are a number of opportunities for the development of mathematical skills especially within the specified practical work in this topic. These include making use of appropriate units; using expressions in decimal and standard form; using ratios, fractions and percentages; finding arithmetic means; the construction of tables and diagrams, bar charts and histograms; translating information between graphical, numerical and algebraic forms; plotting variables from experimental data; understanding that $y= mx + c$ represents a linear relationship; calculating a rate of change from a graph showing a linear relationship; drawing and using the slope of a tangent to a curve as a measure of rate of change.

How Science Works
The understanding of the enzyme model within this topic allows learners to develop the ability to: use theories, models and ideas to develop scientific explanations; use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas; communicate information and ideas in appropriate ways using appropriate terminology. The practical work in addition, allows learners to: carry out experimental and investigative activities, including appropriate risk assessments; analyse and interpret data to provide evidence, recognising correlations and causal relationships; evaluate methodology, evidence and data, and resolve conflicting evidence.

Learners should be able to demonstrate and apply their knowledge and understanding of:

(a) metabolism as a series of enzyme controlled reactions

(b) the protein nature of enzymes

(c) enzymes acting intracellularly or extracellularly

(d) active sites, interpreted in terms of three dimensional structure

(e) the theory of induced fit as illustrated by lysozyme

(f) the meaning of catalysis; the lowering of the activation energy

(g) the influence of temperature, pH, substrate and enzyme concentration on rate of activity and inactivation and denaturation of enzymes and the importance of buffers for maintaining a constant pH

(h) the principles of competitive and non-competitive inhibition

(i) the importance of immobilised enzymes and that industrial processes use immobilised enzymes, allowing enzyme reuse and improving stability

SPECIFIED PRACTICAL WORK

- Investigation into the effect of temperature or pH on enzyme activity
- Investigation into the effect of enzyme or substrate concentration on enzyme activity

Basic Biochemistry and Cell Organisation

5. Nucleic acids and their functions

Overview
Nucleic acids are common to all living organisms and are essential for many functions including inheritance and metabolism.

Working scientifically
The extraction of DNA from living materials gives learners opportunities to develop skills in the use of laboratory apparatus and follow instructions. There are also a number of opportunities here to use ICT such as computer modelling to study protein synthesis and DNA replication.

How Science Works
Studying the structure of nucleotides, nucleic acids and protein synthesis allows learners to develop the ability to: use theories, models and ideas to develop scientific explanations; communicate information and ideas in appropriate ways using appropriate terminology. The consideration of the work of Meselson and Stahl and the 'one gene, one polypeptide' hypothesis allows the evaluation of the role of the scientific community in validating new knowledge and ensuring integrity.

Learners should be able to demonstrate and apply their knowledge and understanding of:

(a) the structure of nucleotides (pentose sugar, phosphate, organic base)

(b) the importance of chemical energy in biological processes

(c) the central role of ATP as an energy carrier and its use in the liberation of energy for cellular activity

(d) the structure of ATP

(e) the structure of nucleic acids: DNA bases: purines-adenine and guanine, pyrimidines-cytosine and thymine; complementary base pair rule; hydrogen bonding and the double helix; antiparallel strands

(f) the similarities and differences in the structure of RNA and DNA

(g) the two major functions of DNA; replication and protein synthesis

(h) the semi-conservative replication of DNA including the roles of DNA polymerase and helicase and be able to use evidence from the Meselson and Stahl experiments

(i) the term genetic code

(j) the triplet code for amino acids

(k) exons as regions of DNA that contain the code for proteins and that between the exons are regions of non-coding DNA called introns

(l) the transcription of DNA to produce messenger RNA

(m) the translation of mRNA using ribosomes and the structure and function of transfer RNA, to synthesise proteins

(n) the 'one gene - one polypeptide' hypothesis

(o) the further modification and combination of some polypeptides

SPECIFIED PRACTICAL WORK

- Simple extraction of DNA from living material

Basic Biochemistry and Cell Organisation

6. Genetic information is copied and passed on to daughter cells

Overview
This topic covers cell division. During the cell cycle, genetic information is copied and passed on to daughter cells.

Working scientifically
The specified practical work in this topic gives learners opportunities to use the light microscope and to produce annotated scientific drawings from observation. There is also the opportunity for learners to produce their own slide of dividing cells in a root tip.

Mathematical Skills
There are a number of opportunities for the development of mathematical skills especially within the microscope work in this topic. These include making use of appropriate units; using ratios, fractions and percentages; using an appropriate number of significant figures and decimal places; making order of magnitude calculations; changing the subject of an equation; substitution of numerical values into algebraic equations.

How Science Works
The understanding of cell division within this topic for learners to develop the ability to: use theories, models and ideas to develop scientific explanations; communicate information and ideas in appropriate ways using appropriate terminology. The significance of unrestricted division leading to cancerous growth could lead to the consideration of applications and implications of science and evaluating their associated benefits and risks.

Learners should be able to demonstrate and apply their knowledge and understanding of:

(a) interphase and the main stages of mitosis

(b) the significance of mitosis as a process in which daughter cells are provided with identical copies of genes and the process of cytokinesis

(c) the significance of mitosis in terms of damage and disease: repeated cell renewal, damage repair and healing and unrestricted division leading to cancerous growth

(d) the main stages of meiosis (names of subdivisions of prophase 1 not required) and cytokinesis

(e) the differences between mitosis and meiosis, including that mitosis produces genetically identical daughter cells whereas meiosis produces non identical daughter cells

SPECIFIED PRACTICAL WORK

- Scientific drawing of cells from slides of root tip to show stages of mitosis
- Scientific drawing of cells from prepared slides of developing anthers to show stages of meiosis

2.2 Component 2

BIODIVERSITY AND PHYSIOLOGY OF BODY SYSTEMS

Written examination: 1 hour 30 minutes
50% of qualification

This component covers study of the following topics:

1. All organisms are related through their evolutionary history
2. Adaptations for gas exchange
3. Adaptations for transport
4. Adaptations for nutrition

Biodiversity and Physiology of Body Systems

1. All organisms are related through their evolutionary history

Overview
This topic covers biodiversity and classification. The variety of living organisms that exists today has evolved as a result of natural selection. Modern techniques have allowed more accurate classification to confirm evolutionary relationships.

Working scientifically
The approach to biodiversity in this topic gives learners opportunities to develop investigative skills. There are a number of opportunities for independent research. These could involve the use of sampling techniques in fieldwork; online and offline research skills including websites, textbooks and other printed scientific sources of information and the correct citation of sources of information.

Mathematical Skills
There are a number of opportunities for the development of mathematical skills especially within the specified practical work in this topic. These include using expressions in decimal and standard form; using ratios, fractions and percentages; selecting a statistical test; understanding simple probablility; using scatter diagrams; construction and interpretation of frequency tables and diagrams; understanding the principles of sampling as applied to scientific data; substitution of numerical values to solve algebraic equations; translating information between graphical, numerical and algebraic forms.

How Science Works
The understanding of classification allows learners to develop the ability to: use theories, models and ideas to develop scientific explanations; use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas. The comparison of three domain and five kingdom systems gives opportunity to: know that scientific knowledge and understanding develops over time; the evaluation of the role of the scientific community in validating new knowledge and ensuring integrity; evaluate the ways in which society uses science to inform decision making. The use of fieldwork develops: appropriate methodology, including information and communication technology (ICT) to answer scientific questions and solve scientific problems; experimental and investigative activities, including appropriate risk assessments; analysis and interpretation skills, recognising correlations and causal relationships; evaluation of methodology, evidence and data, and resolving of conflicting evidence; consider ethical issues in the treatment of other organisms and the environment.

Learners should be able to demonstrate and apply their knowledge and understanding of:

(a) the classification of organisms into groups based on their evolutionary relationships and that classification places organisms into discrete and hierarchical groups with other closely related species

(b) the need for classification and its tentative nature

(c) the three domain classification system as compared with the five Kingdom classification system

(d) the characteristic features of Kingdoms: Prokaryotae, Protoctista, Plantae, Fungi, Animalia

(e) the use of physical features and biochemical methods to assess the relatedness of organisms, including that DNA ‘genetic fingerprinting’ and enzyme studies show relatedness without the problem of morphological convergence

(f) the concept of species

(g) the use of the binomial system in naming organisms

(h) biodiversity as the number and variety of organisms found within a specified geographic region

(i) biodiversity varying spatially and over time and affected by many factors

(j) biodiversity can be assessed in a habitat e.g. Simpson’s Diversity Index,

(k) biodiversity can be assessed within a species at a genetic level by looking at the variety of alleles in the gene pool of a population, i.e. the proportion of polymorphic loci across the genome

(l) biodiversity can be assessed at a molecular level using DNA fingerprinting and sequencing

(m) biodiversity has been generated through natural selection

(n) the different types of adaptations of organisms to their environment including anatomical, physiological and behavioural adaptations

SPECIFIED PRACTICAL WORK

- Investigation into biodiversity in a habitat

Biodiversity and Physiology of Body Systems

2. Adaptations for gas exchange

Overview
This topic is an overview of the adaptations of a variety of organisms for gas exchange. As organisms increase in size and complexity with increasing metabolic rate, there is an increased need for specialised gas exchange surfaces and ventilation mechanisms. The importance of the surface area to volume ratio in organisms is a theme running throughout the topic.

Working scientifically
This topic gives learners opportunities to develop skills in: safely using instruments for dissection in dissecting a fish head; microscope techniques and use of a graticule; producing scientific drawings with annotations.

Mathematical Skills
There are a number of opportunities for the development of mathematical skills. The consideration of the surface area to volume ratio in different organisms and concentration gradients allows: use of appropriate units; using expressions in decimal and standard form; using ratios; calculating the areas and volumes of regular shapes; translating information between graphical and numerical forms. The investigation into stomatal numbers allows: finding arithmetic means; calculating mean, median and mode; constructing and interpreting tables and diagrams; estimating results; plotting experimental data. The microscope work allows: making order of magnitude calculations; changing the subject of an equation; substitution of numerical values into algebraic equations.

How Science Works
The study of the mechanisms by which gas exchange occurs allow learners to develop the ability to: use theories, models and ideas to develop scientific explanations; use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas. The practical work encourages: use of appropriate methodology, including information and communication technology (ICT) to answer scientific questions and solve scientific problems; experimental and investigative activities, including appropriate risk assessments; analysis and interpretation of data to provide evidence, recognising correlations and causal relationships; evaluation of methodology, evidence and data, and resolving of conflicting evidence.

Learners should be able to demonstrate and apply their knowledge and understanding of:

(a) the adaptations for gas exchange which allow an increase in body size and metabolic rate

(b) gas exchange in small animals across their general body surface

(c) the comparison of gas exchange mechanisms in *Amoeba*, flatworm and earthworm

(d) the common features of the specialised respiratory surfaces of larger animals and the adaptation of respiratory surfaces to environmental conditions - fish have gills for aquatic environments and mammals have lungs for terrestrial environments

(e) the need for large active animals with high metabolic rates to have ventilating mechanisms to maintain gradients across respiratory surfaces

(f) ventilation in bony fish and comparison of counter current flow with parallel flow

(g) the structure and function of the human breathing system, including examination of microscope slides of T.S. lung and trachea

(h) ventilation in humans and how gases are exchanged

(i) the adaptations of the insect tracheal system to life in a terrestrial environment

(j) the structure of the angiosperm leaf

(k) the role of leaf structures in allowing the plant to function and photosynthesise effectively

(l) the role of the leaf as an organ of gaseous exchange, including stomatal opening and closing

SPECIFIED PRACTICAL WORK

- Investigation into stomatal numbers in leaves
- Dissection of fish head to show the gas exchange system
- Scientific drawing of a low power plan of a prepared slide of T.S. dicotyledon leaf e.g. *Ligustrum* (privet), including calculation of actual size and magnification of drawing

Biodiversity and Physiology of Body Systems

3. Adaptations for transport

Overview
This topic is an overview of the adaptations of a variety of organisms for transport. As organisms increase in size and complexity, there is an increased need for specialised transport mechanisms.

Working scientifically
This topic gives learners many opportunities to develop practical skills in: safely using instruments for dissection in a heart dissection; microscope techniques and use of a graticule; producing scientific drawings with annotations; using a potometer to record quantitative measurements.

Mathematical Skills
The study of dissociation curves, analysis of electrocardiogram traces and transpiration investigation give a number of opportunities for the development of mathematical skills. These include: use of appropriate units; using ratios; solving algebraic equations; use of significant figures; finding arithmetic means; constructing and interpreting tables; calculating mean, median and mode; estimating results; calculating the areas, circumferences and volumes of regular shapes; translating information between graphical, numerical and algebraic forms; plotting two variables from experimental or other data; understanding that $y = mx + c$ represents a linear relationship; calculating rate of change from a graph; determining the intercept of a graph.

How Science Works
The study of the increasingly complex transport mechanisms in organisms allows learners to develop the ability to: use theories, models and ideas to develop scientific explanations; use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas; communicate information and ideas in appropriate ways using appropriate terminology. The practical work encourages: use of appropriate methodology, including information and communication technology (ICT) to answer scientific questions and solve scientific problems; experimental and investigative activities, including appropriate risk assessments; analysis and interpretation of data to provide evidence, recognising correlations and causal relationships; evaluation of methodology, evidence and data, and resolving of conflicting evidence.
The study of phloem transport gives opportunities for the following: evaluation of methodology, evidence and data, and resolving of conflicting evidence; knowing that scientific knowledge and understanding develops over time.

Learners should be able to demonstrate and apply their knowledge and understanding of:

(a) the similarities and differences in the vascular systems of animal groups:

- Earthworm — vascularisation, closed circulatory system and pumps, carriage of respiratory gases in blood
- Insects — open circulatory system, dorsal tube-shaped heart, lack of respiratory gases in blood
- Fish — single circulatory system
- Mammal — double circulatory system

(b) the mammalian circulatory system including the structure and function of heart and blood vessels and the names of the main blood vessels associated with the human heart

(c) the cardiac cycle and the maintenance of circulation to include graphical analysis of pressure changes, the role of sino-atrial node and Purkyne/ Purkinje fibres and the analysis of electrocardiogram traces to show electrical activity

(d) the function of red blood cells and plasma in relation to transport of respiratory gases, dissociation curves of haemoglobin of mammal (adult and foetus), including examination of microscope slides of erythrocytes

(e) the dissociation curves of some animals adapted to low oxygen level habitats e.g. llama, lugworm

(f) the Bohr effect and chloride shift

(g) the transport of nutrients, hormones, excretory products and heat in the blood

(h) the formation of tissue fluid and its importance as a link between blood and cells

(i) the structure of the dicotyledon root, including examination of microscope slides of T.S. dicotyledon root

(j) the absorption of water by the root

(k) the movement of water through the root: apoplast, symplast and vacuolar pathways

(l) the structure and understand the role of the endodermis

(m) the detailed structure of xylem as seen by the light and electron microscope, including examination of microscope slides of T.S. dicotyledon primary stem

(n) the movement of water from root to leaf including the transpiration stream and cohesion-tension theory

(o) the effect of environmental factors affecting transpiration

(p) the adaptations shown by some angiosperms: hydrophytes, xerophytes, including examination of microscope slides of T.S. leaves of marram grass and water lily

(q) the detailed structure of phloem as seen by the light and electron microscope

(r) understand the translocation of organic materials from source to sink, including the ideas surrounding phloem transport: diffusion; cytoplasmic strands; mass flow models; experimental evidence that solutes e.g. sucrose, are carried in the phloem; use of aphids and autoradiographs

SPECIFIED PRACTICAL WORK

- Investigation into transpiration using a simple potometer
- Scientific drawing of a low power plan of a prepared slide of T.S artery and vein, including calculation of actual size and magnification of drawing
- Dissection of mammalian heart

Biodiversity and Physiology of Body Systems

4. Adaptations for nutrition

Overview
This topic is an overview of the adaptations for nutrition in a variety of organisms. As organisms increase in size and complexity, there is an increased need for specialised digestive systems.

Working scientifically
There are a number of opportunities in this topic to develop practical skills. These include microscope skills in the observation of the histology of T.S. duodenum and Ileum; observation of skulls and dentition of a herbivore and a carnivore; observation of specimens and slides of tapeworm e.g. *Taenia*

Mathematical Skills
The comparison of the adaptations for nutrition in different organisms allows a number of opportunities for the development of mathematical skills. These include: use of appropriate units; using ratios; solving algebraic equations; estimating results; translating information between graphical, numerical and algebraic forms. Microscope work allows: making order of magnitude calculations; changing the subject of an equation; substitution of numerical values into algebraic equations.

How Science Works
The study of the different nutrition mechanisms within this topic allow learners to develop the ability to: analyse and interpret data to providing evidence, recognise correlations and causal relationships; communicate information and ideas in appropriate ways using appropriate terminology; consider applications and implications of science and evaluate their associated benefits and risks.

Learners should be able to demonstrate and apply their knowledge and understanding of:

(a) the terms autotrophic and heterotrophic and that autotrophic organisms can be photoautotrophic or chemoautotrophic

(b) the terms saprotrophic/saprobiotic, holozoic, parasitic in relation to heterotrophic organisms

(c) saprotrophic nutrition involving the secretion of enzymes, external digestion of food substances followed by absorption of the products of digestion into the organism, e.g. fungi

(d) holozoic nutrition, the internal digestion of food substances

(e) nutrition in unicellular organisms, e.g. *Amoeba*, food particles are absorbed and digestion is carried out intracellularly

(f) the adaptation of multicellular organisms for nutrition showing increasing levels of adaptation from a simple, undifferentiated, sac-like gut with a single opening, e.g. *Hydra*, to a tube gut with different openings for ingestion and egestion and specialised regions for the digestion of different food substance

(g) the adaptations of the human gut to a mixed, omnivorous diet that includes both plant and animal material, including examination of microscope slides of duodenum and ileum

(h) the efficient digestion of different food substances requiring different enzymes and different conditions

(i) the adaptations of herbivore guts and dentition, in particular ruminants to a high cellulose diet and the adaptations of carnivore guts and dentition to a high protein diet, including examination of skulls and dentitiion of a herbivore and a carnivore

(j) parasites; highly specialised organisms that obtain their nutrition at the expense of a host organism e.g. *Taenia* and *Pediculus,* including examination of specimens and slides of tapeworm e.g. *Taenia*

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, processes, techniques and procedures

AO2
Apply knowledge and understanding of scientific ideas, processes, techniques and procedures:
- in a theoretical context
- in a practical context
- when handling qualitative data
- when handling quantitative data

AO3
Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to:
- make judgements and reach conclusions
- develop and refine practical design and 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	18%	22%	10%
Component 2	18%	22%	10%
Overall weighting	36%	44%	20%

For each series:
- the weighting for the assessment of mathematical skills will be a minimum of 10%
- the weighting for the indirect assessment of practical skills will be a minimum of 15%

The ability to select, organise and communicate information and ideas coherently using appropriate scientific conventions and vocabulary will be tested across the assessment objectives.

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. Assessment opportunities will be available in the months of May/June each year, from 2016, until the end of the life of this specification.

Where candidates wish to re-sit the qualification, all components must be re-taken.

The entry code appears below.

WJEC Eduqas AS Biology: B400QS

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

4.2 Grading, awarding and reporting

AS qualifications are reported as a grade on the scale from A to E. Results not attaining the minimum standard for the award will be reported as U (unclassified).

AS qualifications are free-standing and are awarded in their own right. Assessments at AS cannot contribute to an A level grade.

APPENDIX A

WORKING SCIENTIFICALLY

Practical skills identified for indirect assessment and developed through teaching and learning

Question papers will assess learners' abilities to:

Independent thinking

- solve problems set in practical contexts
- apply scientific knowledge to practical contexts

Use and application of scientific methods and practices

- comment on experimental design and evaluate scientific methods
- present data in appropriate ways
- evaluate results and draw conclusions with reference to measurement uncertainties and errors
- identify variables including those that must be controlled

Numeracy and the application of mathematical concepts in a practical context

- plot and interpret graphs
- process and analyse data using appropriate mathematical skills as exemplified in the mathematical appendix (see Appendix B)
- consider margins of error, accuracy and precision of data

Instruments and equipment

- know and understand how to use a wide range of experimental and practical instruments, equipment and techniques appropriate to the knowledge and understanding included in the specification

APPENDIX B

MATHEMATICAL REQUIREMENTS AND EXEMPLIFICATION

Mathematical skills	**Exemplification of mathematical skill in the context of AS Biology (assessment is not limited to the examples given below)**	**Areas of the specification which exemplify the mathematical skill (assessment is not limited to the examples below)**
Arithmetic and numerical computation		
Recognise and make use of appropriate units in calculations	Learners may be tested on their ability to: • convert between units, e.g. mm^3 to cm^3 as part of volumetric calculations • work out the unit for a rate e.g. breathing rate	1.1(c), 1.1(f), 1.1(h), 1.2(c), 1.2(d), 1.3(b),1.3(c), 1.4(g), 1.4(h), 2.2(a), 2.2(c), 2.2(d), 2.3(a), 2.3(c), 2.3(d), 2.3(o), 2.4(i),
Recognise and use expressions in decimal and standard form	Learners may be tested on their ability to: • use an appropriate number of decimal places in calculations, e.g. for a mean • carry out calculations using numbers in standard and ordinary form, e.g. use of magnification • understand standard form when applied to areas such as size of organelles • convert between numbers in standard and ordinary form • understand that significant figures need retaining when making conversions between standard and ordinary form, e.g. 0.0050 mol dm^{-3} is equivalent to 5.0×10^{-3} mol dm^{-3}	1.2(a), 1.2(c), 1.2(d), 1.3(b), 1.3(c), 1.4(g), 1.4(h), 1.6(a) 2.1(j), 2.2(a), 2.2 (c), 2.2 (d), 2.3(d)

Use ratios, fractions and percentages	Learners may be tested on their ability to: • calculate percentage yields • calculate surface area to volume ratio • use scales for measuring • represent phenotypic (monohybrid and dihybrid crosses)	1.1(c), 1.1(f), 1.1(j), 1.2(a), 1.2(c), 1.2(d), 1.6(a), 1.6(d) 1.3(b), 1.3(c), 1.4(g), 1.4(h), 2.1(j), 2.1 (k), 2.1(l), 2.2(a), 2.2 (c), 2.2 (d), 2.3d, 2.3(o)
Estimate results	Learners may be tested on their ability to: • estimate results to sense check that the calculated values are appropriate	1.3(b), 1.3(c), 2.2(a), 2.3a) 2.4(i)
Handling data		
Use an appropriate number of significant figures	Learners may be tested on their ability to: • report calculations to an appropriate number of significant figures given raw data quoted to varying numbers of significant figures • understand that calculated results can only be reported to the limits of the least accurate measurement	1.2(a), 1.2(c), 1.2(d), 1.3(b), 1.3(c), 1.4(g), 1.4(h), 2.1(j), 2.1(k), 2.1(l), 2.2(a), 2.2(c), 2.2(d), 2.3(d)
Find arithmetic means	Learners may be tested on their ability to: • find the mean of a range of data, e.g. the mean number of stomata in the leaves of a plant	1.3(b), 1.3(c), 1.4(g), 1.4(h), 1.2(l), 2.3(o)
Construct and interpret frequency tables and diagrams, bar charts and histograms	Learners may be tested on their ability to: • represent a range of data in a table with clear headings, units and consistent decimal places • interpret data from a variety of tables, e.g. data relating to organ function • plot a range of data in an appropriate format, e.g. enzyme activity over time represented on a graph • interpret data for a variety of graphs, e.g. explain electrocardiogram traces	1.1(c), 1.1(f), 1.1(h), 1.3(b), 1.3(c), 1.4(g), 1.4(h), 2.1(h), 2.2(d), 2.2(e), 2.2(f), 2.2(l), 2.3(c), 2.3(d), 2.3(e), 2.3(f), 2.3(o)

Understand simple probability	Learners may be tested on their ability to: • use the terms probability and chance appropriately • understand the probability associated with genetic inheritance	2.1(j)
Understand the principles of sampling as applied to scientific data	Learners may be tested on their ability to: • analyse random data collected by an appropriate means, e.g. use Simpson's Diversity Index to calculate the biodiversity of a habitat	2.1(j)
Understand the terms mean, median and mode	Learners may be tested on their ability to: • calculate or compare the mean, median and mode of a set of data, e.g. height/mass/size of a group of organisms	1.3(b), 1.3(c), 1.4(g), 1.4(h), 2.2(l), 2.3(o)
Use a scatter diagram to identify a correlation between two variables	Learners may be tested on their ability to: • interpret a scattergram, e.g. the effect of life style factors on health	1.1(c), 1.1(f), 1.1(), 1.3(b), 1.3(c), 1.4(g), 1.4(h), 2.1(h), 2.2(d), 2.2(e), 2.2(f), 2.2(l), 2.3(e), 2.3(o)
Make order of magnitude calculations	Learners may be tested on their ability to: • use and manipulate the magnification formula magnification = $\frac{\text{size of image}}{\text{size of real object}}$	1.2(a), 1.2(c), 1.2(d), 1.6(a), 2.2(g), 2.3(i),2.4(g)
Select and use a statistical test	Learners may be tested on their ability to select and use: • the chi squared test to test the significance of the difference between observed and expected results • the Student's t-test • the correlation coefficient	2.1(j)

Understand measures of dispersion, including standard deviation and range	Learners may be tested on their ability to: • calculate the standard deviation • understand why standard deviation might be a more useful measure of dispersion for a given set of data e.g. where there is an outlying result	1.3(b), 1.3(c), 1.4(g), 1.4(h)
Identify uncertainties in measurements and use simple techniques to determine uncertainty when data are combined	Learners may be tested on their ability to: • calculate percentage error where there are uncertainties in measurement	1.3(b), 1.3(c), 1.4(g), 1.4(h)
Algebra		
Understand and use the symbols: =, <, <<, >>, >, ∝, ~.	No exemplification required.	1.2(a), 1.2(b),1.3(b), 1.3(c)
Change the subject of an equation	Learners may be tested on their ability to: • use and manipulate equations, e.g. magnification	1.2(a), 1.2(c), 1.2(d), 1.3(c), 1.6(a)
Substitute numerical values into algebraic equations using appropriate units for physical quantities	Learners may be tested on their ability to: • use a given equation e.g. Simpson's Diversity Index	1.2(a), 1.2(c), 1.2(d), 1.3(c), 1.6(a), 2.1(j), 2.2(g), 2.4(g)
Solve algebraic equations	Learners may be tested on their ability to: • solve equations in a biological context, e.g. cardiac output = stroke volume x heart rate	1.2(a), 1.2(c), 1.2(d), 1.3(c), 2.1(j), 2.2(g), 2.4(g)
Graphs		
Translate information between graphical, numerical and algebraic forms	Learners may be tested on their ability to: • understand that data may be presented in a number of formats and be able to use these data, e.g. dissociation curves	1.3(b), 1.3(c), 1.4(g), 1.4(h), 2.1(h), 2.2(d), 2.2(e), 2.2(f), 2.2(l), 2.3(c), 2.3(d), 2.3(e), 2.3(f), 2.3(o), 2.4(g)

Plot two variables from experimental or other data	Learners may be tested on their ability to: • select an appropriate format for presenting data, bar charts, histograms, graphs and scattergrams	1.3(b), 1.3(c), 1.4(g), 1.4(h), 2.1(h), 2.2(e), 2.2(f), 2.2(l), 2.3(o)
Understand that $y = mx + c$ represents a linear relationship	Learners may be tested on their ability to: • predict/sketch the shape of a graph with a linear relationship, e.g. the effect of substrate concentration on the rate of an enzyme-controlled reaction with excess enzyme	1.3(b), 1.3(c), 1.4(g), 1.4(h)
Calculate rate of change from a graph showing a linear relationship	Learners may be tested on their ability to: • calculate a rate from a graph, e.g. rate of transpiration	1.3(b), 1.3(c), 1.4(g), 1.4(h), 2.3(o)
Draw and use the slope of a tangent to a curve as a measure of rate of change	Learners may be tested on their ability to: • use this method to measure the gradient of a point on a curve, e.g. amount of product formed plotted against time when the concentration of enzyme is fixed	1.3(b), 1.3(c), 1.4(g), 1.4(h), 2.3(o)
Geometry and trigonometry		
Calculate the circumferences, surface areas and volumes of regular shapes	Learners may be tested on their ability to: • calculate the circumference and area of a circle • calculate the surface area and volume of rectangular prisms, of cylindrical prisms and of spheres e.g. calculate the surface area or volume of a cell	1.3(b), 1.3(c), 2.2(a), 2.3(o), 2.3(p)

APPENDIX C

HOW SCIENCE WORKS REQUIREMENTS AND EXEMPLIFICATION

How Science Works Skill	Areas of the specification which exemplify the how science works skill (assessment is not limited to the examples below)
use theories, models and ideas to develop scientific explanations	1.1(d), 1.2(c), 1.3(a), 1.4(d), 1.4(d), 1.5(a), 1.5(e), 1.5(h), 1.5(l), 1.5(m), 1.6(a), 1.6(d), 2.1(a), 2.1(b), 1.2(a), 1.2 (f), 2.3(c), 2.3(k), 2.3(o), 2.3(r)
use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas	1.1(b), 1.2(a), 1.2(b), 1.3(c), 1.4(g), 2.1(j), 2.1(k), 2.1(l), 2.2(c), 2.2(k), 2.3(a), 2.3(c), 2.3(o)
use appropriate methodology, including information and communication technology (ICT), to answer scientific questions and solve scientific problems	1.1(c), 1.1(e), 1.1(h), 1.3(c), 2.1(j), 2.2 (f), 2.2 (c), 2.2(k), 2.3(a), 2.3(o)
carry out experimental and investigative activities, including appropriate risk management, in a range of contexts	1.1(c), 1.1(e), 1.1(h), 1.2(c), 1.2(d), 1.3(c), 1.4(g), 1.5(e), 2.1(j), 2.2(k), 2.3(o)
analyse and interpret data to provide evidence, recognising correlations and causal relationships	1.3(c), 1.4(g), 2.1(j), 2.2(k), 2.3(c), 2.3(d), 23(e), 2.3(o), 2.4(g), 2.4(i)
evaluate methodology, evidence and data, and resolve conflicting evidence	1.3(c), 1.4(g), 2.1(j), 2.2(k), 2.3(o)
know that scientific knowledge and understanding develops over time	1.2(c), 1.4(e), 2.1(c), 2.1(e), 2.3(r)
communicate information and ideas in appropriate ways using appropriate terminology	1.1(c), 1.1(e), 1.1(h), 1.2(a), 1.4(g), 1.5(a), 1.5(e), 1.5(h), 1.5(l), 1.5(m), 1.6(a), 1.6(d), 2.3(c), 2.3(d), 2.4(a), 2.4(b)
consider applications and implications of science and evaluate their associated benefits and risks	1.1(g), 1.4(i), 1.6(c), 2.4(j)
consider ethical issues in the treatment of humans, other organisms and the environment	1.5(m), 1.5(n), 1.5(o), 1.6(a), 1.6(b), 1.6(c), 2.1(k), 2.1(i)
evaluate the role of the scientific community in validating new knowledge and ensuring integrity	1.6(c), 2.1(b), 2.1(c), 2.1(e), 2.1(i)
evaluate the ways in which society uses science to inform decision making.	1.1(g), 1.5(m), 1.5(n), 1.5(o), 1.6(c), 1.6(d), 1.6(e), 1.6(f), 2.1(b), 2.1(c), 2.1(i)