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AS Biology A (Salters-Nuffield)

Specification

Pearson Edexcel Level 3 Advanced Subsidiary GCE in Biology A (Salters-Nuffield) (8BN0)

First teaching from September 2015

First certification from 2016

Issue 2

ALWAYS LEARNING

PEARSON

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Original origami artwork: Mark Bolitho

Origami photography: Pearson Education Ltd/Naki Kouyioumtzis

ISBN 978 1 446 93090 8

From Pearson's Expert Panel for World Class Qualifications

"The reform of the qualifications system in England is a profoundly important change to the education system. Teachers need to know that the new qualifications will assist them in helping their learners make progress in their lives.

When these changes were first proposed we were approached by Pearson to join an 'Expert Panel' that would advise them on the development of the new qualifications.

We were chosen, either because of our expertise in the UK education system, or because of our experience in reforming qualifications in other systems around the world as diverse as Singapore, Hong Kong, Australia and a number of countries across Europe.

We have guided Pearson through what we judge to be a rigorous qualification development process that has included:

- extensive international comparability of subject content against the highest-performing jurisdictions in the world
- benchmarking assessments against UK and overseas providers to ensure that they are at the right level of demand
- establishing External Subject Advisory Groups, drawing on independent subject-specific expertise to challenge and validate our qualifications
- subjecting the final qualifications to scrutiny against the DfE content and Ofqual accreditation criteria in advance of submission.

Importantly, we have worked to ensure that the content and learning is future oriented. The design has been guided by what is called an 'Efficacy Framework', meaning learner outcomes have been at the heart of this development throughout.

We understand that ultimately it is excellent teaching that is the key factor to a learner's success in education. As a result of our work as a panel we are confident that we have supported the development of qualifications that are outstanding for their coherence, thoroughness and attention to detail and can be regarded as representing world-class best practice."

Sir Michael Barber (Chair)
Chief Education Advisor, Pearson plc

Bahram Bekhradnia
President, Higher Education Policy Institute

Dame Sally Coates
Principal, Burlington Danes Academy

Professor Robin Coningham
Pro-Vice Chancellor, University of Durham

Dr Peter Hill
Former Chief Executive ACARA

Professor Sing Kong Lee
Director, National Institute of Education, Singapore

Professor Jonathan Osborne
Stanford University

Professor Dr Ursula Renold
Federal Institute of Technology, Switzerland

Professor Bob Schwartz
Harvard Graduate School of Education

Introduction

The Pearson Edexcel Level 3 Advanced Subsidiary GCE in Biology A (Salters-Nuffield) is designed for use in schools and colleges. It is part of a suite of GCE qualifications offered by Pearson.

Purpose of the specification

This specification sets out:

- the objectives of the qualification
- any other qualification(s) that a student must have completed before taking the qualification
- any prior knowledge and skills that the student is required to have before taking the qualification
- any other requirements that a student must have satisfied before they will be assessed or before the qualification will be awarded
- the knowledge and understanding that will be assessed as part of the qualification
- the method of assessment and any associated requirements relating to it
- the criteria against which a student's level of attainment will be measured (such as assessment criteria).

Rationale

The Pearson Edexcel Level 3 Advanced Subsidiary GCE in Biology A (Salters-Nuffield) meets the following purposes, which fulfil those defined by the Office of Qualifications and Examinations Regulation (Ofqual) for GCE qualifications in their *GCE Qualification Level Conditions and Requirements* document, published in April 2014.

The purposes of this qualification are to:

- provide evidence of student achievements in a robust and internationally comparable post-16 course of study that is a sub-set of Advanced GCE content
- enable students to broaden the range of subjects they study.

Qualification aims and objectives

The aims and objectives of the Pearson Edexcel Level 3 Advanced Subsidiary GCE in Biology A (Salters-Nuffield) are to enable students to develop:

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

The context for the development of this qualification

All our qualifications are designed to meet our World Class Qualification Principles[1] and our ambition to put the student at the heart of everything we do.

We have developed and designed this qualification by:

- reviewing other curricula and qualifications to ensure that it is comparable with those taken in high-performing jurisdictions overseas
- consulting with key stakeholders on content and assessment, including subject associations, higher education academics, teachers and employers to ensure this qualification is suitable for a UK context
- reviewing the legacy qualification and building on its positive attributes.

This qualification has also been developed to meet criteria stipulated by Ofqual in their document *GCE Qualification Level Conditions and Requirements* and by the Department for Education (DfE) in their *GCE AS and A level regulatory requirements for biology, chemistry, physics and psychology* document, published in April 2014.

[1] Pearson's World Class Qualification principles ensure that our qualifications are:

- **demanding**, through internationally benchmarked standards, encouraging deep learning and measuring higher-order skills
- **rigorous**, through setting and maintaining standards over time, developing reliable and valid assessment tasks and processes, and generating confidence in end users of the knowledge, skills and competencies of certified students
- **inclusive**, through conceptualising learning as continuous, recognising that students develop at different rates and have different learning needs, and focusing on progression
- **empowering**, through promoting the development of transferable skills, see *Appendix 1*.

Contents

Qualification at a glance

The Pearson Edexcel Level 3 Advanced Subsidiary GCE in Biology A (Salters-Nuffield) consists of two externally examined papers.

Students are expected to carry out the nine core practical experiments that are identified in the content.

Students must complete both assessments in May/June in any single year.

Paper 1: Lifestyle, Transport, Genes and Health **Paper code: 8BN0/01*	
• Externally assessed • Availability: May/June • First assessments: 2016	**50% of the total qualification**

Overview of content

This paper will examine the following topics:

- Topic 1: Lifestyle, Health and Risk
- Topic 2: Genes and Health.

Overview of assessment

- Assessment is 1 hour 30 minutes.
- The paper consists of 80 marks.
- The paper may include multiple-choice, short open, open-response, calculations and extended writing questions.
- The paper will include questions that target mathematics at Level 2 or above (see *Appendix 5: Mathematical skills and exemplifications*). Overall, a minimum of 10% of the marks across the three papers will be awarded for mathematics at Level 2 or above.
- The paper will include questions that target the conceptual and theoretical understanding of experimental methods.

Paper 2: Development, Plants and the Environment *Paper code: 8BN0/02	
• Externally assessed • Availability: May/June • First assessments: 2016	**50% of the total qualification**
Overview of content This paper will examine the following topics: • Topic 3: Voice of the Genome • Topic 4: Biodiversity and Natural Resources.	
Overview of assessment • Assessment is 1 hour 30 minutes. • The paper consists of 80 marks. • The paper may include multiple-choice, short open, open-response, calculations and extended writing questions. • The paper will include questions that target mathematics at Level 2 or above (see *Appendix 5: Mathematical skills and exemplifications*). Overall, a minimum of 10% of the marks across the three papers will be awarded for mathematics at Level 2 or above. • The paper will include questions that target the conceptual and theoretical understanding of experimental methods.	

*See *Appendix 3: Codes* for a description of this code and all other codes relevant to this qualification.

Presentation by themes

The 'Knowledge, skills and understanding' for Biology A (Salters-Nuffield) are shown in the content in a topic-based format, corresponding to Salters-Nuffield approach.

For centres who wish to teach the same content, but in a more concept-based approach, an alternative presentation of topics appears in *Appendix 7: Presentation by themes*.

Knowledge, skills and understanding

Content overview

Students will be expected to demonstrate and apply the knowledge, understanding and skills described in the content for each topic below. In addition, they will be expected to analyse, interpret and evaluate a range of scientific information, ideas and evidence using their knowledge, understanding and skills.

To demonstrate knowledge, students should be able to undertake a range of activities, including the ability to recall, describe and define, as appropriate. To demonstrate understanding, students should be able to explain ideas and use their knowledge to apply, analyse, interpret and evaluate, as appropriate.

Core practicals will be assessed by examination.

Each topic begins with an overview of the wider biological context designed to encourage an overarching approach to both the teaching and learning of the subject. As such, it will not be directly assessed.

There are opportunities for students to develop mathematical skills throughout the content. They are required to apply the skills to relevant biology contexts. In order to be able to develop their skills, knowledge and understanding in science, students need to have been taught, and to have acquired competence in, the appropriate areas of mathematics relevant to the subject. These skills will be applied in the context of the Biology and will be developed throughout the course. The relevant mathematical skills listed in *Appendix 5* must be assessed within the lifetime of the qualification.

Practical skills

Practical work is central to any study of biology. For this reason, the specification includes nine core practical activities which form a thread linking theoretical knowledge and understanding to practical scenarios. In following this thread, students will build on practical skills learned at GCSE, becoming confident practical biologists, handling apparatus competently and safely. Using a variety of apparatus and techniques, they should be able to design and carry out both the core practical activities and their own investigations, collecting data which can be analysed and used to draw valid conclusions.

One important aspect of practical work is the ability to evaluate and manage potential risks. The variety of different practical techniques and scenarios in the core practical activities give students scope to consider risk management in different contexts.

Students should also consider the ethical issues presented by their work in the laboratory, which might include consideration for the ethical use of live subjects, the safe disposal of waste materials, and appropriate consideration for other people involved in their own work or who is working nearby.

Also central to the development of practical skills is the ability to communicate information and ideas through the use of appropriate terminology and ICT. Being able to communicate clearly the findings of practical work is arguably as important as the collection of accurate data.

In carrying out practical activities, students will be expected to use their knowledge and understanding to pose scientific questions which can be investigated through experimental activities. Such activities will enable students to collect data, analyse it for correlations and causal relationships, and to develop solutions to the questions posed.

Questions within written examination papers will aim to assess the knowledge and understanding that students gain while carrying out practical activities, within the context of the nine core practical activities, as well as in novel practical scenarios. The written papers will test the skills of students in planning practical work – both in familiar and unfamiliar applications – including risk management and the selection of apparatus, with reasons. As part of data handling, students will be expected to use significant figures appropriately, to process data and to plot graphs. In analysing outcomes and drawing valid conclusions, students should critically consider methods and data, including assessing measurement uncertainties and errors.

Examination papers will also provide the opportunity for students to evaluate the wider role of the scientific community in validating new knowledge and the ways in which society as a whole uses science to inform decision making. Within this, they could be asked to consider the implications and applications of biology in terms of associated benefits and risks. Students may also be asked to evaluate methodology, evidence and data and resolve conflicting evidence.

Success in questions that indirectly assess practical skills within written papers will come more naturally to those candidates who have a solid foundation of laboratory practice and who, having carried them out, have a thorough understanding of practical techniques. Therefore, where possible, teachers should consider adding additional experiments to the core practical activities.

Topic 1: Lifestyle, Health and Risk

This topic builds on students' knowledge and understanding of the functioning of the circulatory system and the importance of lifestyle choices to health. The role of diet and other lifestyle factors in maintenance of good health is considered with particular reference to the heart and circulation and to cardiovascular disease (CVD). The structures and functions of some carbohydrates and lipids are also detailed within this context. Ideas about correlation, causation and the concept of risks to health are covered.

Students should be encouraged to carry out a range of practical experiments related to this topic in order to develop their practical skills. In addition to the core practicals detailed below possible experiments include heart dissection to relate heart structure to function, investigation of the structure blood vessels by measuring the elastic recoil of arteries and veins and by examining slides of blood vessels, measurement of blood pressure, and investigation of the hydrolysis of disaccharides.

Opportunities for developing mathematical skills within this topic include calculating probabilities, plotting two variables from experimental data, calculating % change, substituting numerical values into algebraic equations using appropriate units for physical quantities, constructing and interpreting frequency tables and diagrams, bar charts and histograms, translating information between graphical, numerical and algebraic forms and using scatter diagrams to identify a correlation between two variables. (Please see *Appendix 5: Mathematical skills and exemplifications* for further information.)

Students should:	
1.1	Understand why many animals have a heart and circulation (mass transport to overcome limitations of diffusion in meeting the requirements of organisms).
1.2	Understand the importance of water as a solvent in transport, including its dipole nature.
1.3	Understand how the structures of blood vessels (capillaries, arteries and veins) relate to their functions.
1.4	i) Know the cardiac cycle (atrial systole, ventricular systole and cardiac diastole) and relate the structure and operation of the mammalian heart, including the major blood vessels, to its function. ii) Know how the relationship between heart structure and function can be investigated practically.
1.5	Understand the course of events that leads to atherosclerosis (endothelial dysfunction, inflammatory response, plaque formation, raised blood pressure).
1.6	Understand the blood-clotting process (thromboplastin release, conversion of prothrombin to thrombin and fibrinogen to fibrin) and its role in cardiovascular disease (CVD).
1.7	Know how factors such as genetics, diet, age, gender, high blood pressure, smoking and inactivity increase the risk of cardiovascular disease (CVD).
1.8	Be able to analyse and interpret quantitative data on illness and mortality rates to determine health risks, including distinguishing between correlation and causation and recognising conflicting evidence.

Students should:	
1.9	Be able to evaluate the design of studies used to determine health risk factors, including sample selection and sample size used to collect data that is both valid and reliable.
1.10	Understand why people's perceptions of risks are often different from the actual risks, including underestimating and overestimating the risks due to diet and other lifestyle factors in the development of heart disease.
1.11	i) Be able to analyse data on energy budgets and diet. ii) Understand the consequences of energy imbalance, including weight loss, weight gain, and development of obesity.
1.12	i) Know the difference between monosaccharides, disaccharides and polysaccharides, including glycogen and starch (amylose and amylopectin). ii) Be able to relate the structures of monosaccharides, disaccharides and polysaccharides to their roles in providing and storing energy (β-glucose and cellulose are not required in this topic).
1.13	Know how monosaccharides join to form disaccharides (sucrose, lactose and maltose) and polysaccharides (glycogen and amylose) through condensation reactions forming glycosidic bonds, and how these can be split through hydrolysis reactions.
1.14	i) Know how a triglyceride is synthesised by the formation of ester bonds during condensation reactions between glycerol and three fatty acids. ii) Know the differences between saturated and unsaturated lipids.
1.15	i) Be able to analyse and interpret data on the possible significance for health of blood cholesterol levels and levels of high-density lipoproteins (HDLs) and low-density lipoproteins (LDLs). ii) Know the evidence for a causal relationship between blood cholesterol levels (total cholesterol and LDL cholesterol) and cardiovascular disease (CVD).
1.16	Understand how people use scientific knowledge about the effects of diet, including obesity indicators, body mass index and waist-to-hip ratio, exercise and smoking to reduce their risk of coronary heart disease.
CORE PRACTICAL 1:	Investigate the effect of caffeine on heart rate in *Daphnia*.
1.17	Be able discuss the potential ethical issues regarding the use of invertebrates in research.
CORE PRACTICAL 2:	Investigate the vitamin C content of food and drink.
1.18	Know the benefits and risks of treatments for cardiovascular disease (CVD) (antihypertensives, statins, anticoagulants and platelet inhibitors).

Topic 2: Genes and Health

This topic considers the following biological principles through the context of the genetic disease cystic fibrosis: the properties of and transport of materials, across cell membranes and gas exchange surfaces, DNA structure and replication, protein synthesis, enzymes and monohybrid inheritance through the context of the genetic disease cystic fibrosis. The topic also allows for discussion of the social and ethical issues surrounding the genetic screening for genetic conditions.

Students should be encouraged to carry out a range of practical experiments related to this topic in order to develop their practical skills. In addition to the core practicals detailed below possible experiments include investigation of the effect of surface are to volume ration on uptake by diffusion, examination of slides of alveoli to observe the features that aid diffusion into the bloodstream, and investigation of osmosis and diffusion across membranes, and investigate inheritance using, for example, corn ears.

Opportunities for developing mathematical skills within this topic include calculating areas of circumferences and areas of circles, surface areas and volumes of rectangular blocks and spheres, using ratios, fractions and percentages, plotting two variables from experimental or other data, determining the slope and intercepts of a linear graph, understand that y=mx+c represents a linear relationship, drawing and using the slope of a tangent to a curve as a measurement of rate of change, understanding simple probability and completing a statistical test. (Please see *Appendix 5: Mathematical skills and exemplifications* for further information.)

Students should:	
2.1	i) Know the properties of gas exchange surfaces in living organisms (large surface area to volume ratio, thickness of surface, difference in concentration). ii) Understand how the rate of diffusion is dependent on these properties and can be calculated using Fick's Law of Diffusion. iii) Understand how the structure of the mammalian lung is adapted for rapid gaseous exchange.
2.2	i) Know the structure and properties of cell membranes. ii) Understand how models such as the fluid mosaic model of cell membranes are interpretations of data used to develop scientific explanations of the structure and properties of cell membranes.
CORE PRACTICAL 3:	Investigate membrane structure, including the effect of alcohol concentration or temperature on membrane permeability.
2.3	Understand what is meant by osmosis in terms of the movement of free water molecules through a partially permeable membrane (consideration of water potential is not required).
2.4	i) Understand what is meant by passive transport (diffusion, facilitated diffusion), active transport (including the role of ATP as an immediate source of energy), endocytosis and exocytosis. ii) Understand the involvement of carrier and channel proteins in membrane transport.

Students should:	
2.5	i) Know the basic structure of mononucleotides (deoxyribose or ribose linked to a phosphate and a base, including thymine, uracil, cytosine, adenine or guanine) and the structures of DNA and RNA (polynucleotides composed of mononucleotides linked through condensation reactions). ii) Know how complementary base pairing and the hydrogen bonding between two complementary strands are involved in the formation of the DNA double helix.
2.6	i) Understand the process of protein synthesis (transcription) including the role of RNA polymerase, translation, messenger RNA, transfer RNA, ribosomes and the role of start and stop codons. ii) Understand the roles of the DNA template (antisense) strand in transcription, codons on messenger RNA and anticodons on transfer RNA.
2.7	Understand the nature of the genetic code (triplet code, non-overlapping and degenerate).
2.8	Know that a gene is a sequence of bases on a DNA molecule that codes for a sequence of amino acids in a polypeptide chain.
2.9	i) Know the basic structure of an amino acid (structures of specific amino acids are not required). ii) Understand the formation of polypeptides and proteins (amino acid monomers linked by peptide bonds in condensation reactions). iii) Understand the significance of a protein's primary structure in determining its three-dimensional structure and properties (globular and fibrous proteins and the types of bonds involved in its three-dimensional structure). iv) Know the molecular structure of a globular protein and a fibrous protein and understand how their structures relate to their functions (including haemoglobin and collagen).
2.10	i) Understand the mechanism of action and the specificity of enzymes in terms of their three-dimensional structure. ii) Understand that enzymes are biological catalysts that reduce activation energy. iii) Know that there are intracellular enzymes catalysing reactions inside cells and extracellular enzymes produced by cells catalysing reactions outside of cells.
CORE PRACTICAL 4:	Investigate the effect of enzyme and substrate concentrations on the initial rates of reactions.
2.11	i) Understand the process of DNA replication, including the role of DNA polymerase. ii) Understand how Meselson and Stahl's classic experiment provided new data that supported the accepted theory of replication of DNA and refuted competing theories.
2.12	i) Understand how errors in DNA replication can give rise to mutations. ii) Understand how cystic fibrosis results from one of a number of possible gene mutations.

Students should:	
2.13	i) Know the meaning of the terms: gene, allele, genotype, phenotype, recessive, dominant, incomplete dominance, homozygote and heterozygote. ii) Understand patterns of inheritance, including the interpretation of genetic pedigree diagrams, in the context of monohybrid inheritance.
2.14	Understand how the expression of a gene mutation in people with cystic fibrosis impairs the functioning of the gaseous exchange, digestive and reproductive systems.
2.15	i) Understand the uses of genetic screening, including the identification of carriers, pre-implantation genetic diagnosis (PGD) and prenatal testing, including amniocentesis and chorionic villus sampling. ii) Understand the implications of prenatal genetic screening.
2.16	Be able to identify and discuss the social and ethical issues related to genetic screening from a range of ethical viewpoints.

Topic 3: Voice of the Genome

This topic follows the development of multicellular organisms from single cells to complex individuals. Cell structure and ultrastructure, cell division, the importance of fertilisation, the roles of stem cells, gene expression, cell differentiation and tissue organisation are all considered within this topic, as is the role of the genotype, epigenetics and the effect of environment on phenotype.

Students should be encouraged to carry out a range of practical experiments related to this topic in order to develop their practical skills. In addition to the core practicals detailed below possible experiments include examination of animal cells under the microscope and using electron micrographs, plant tissue culture to demonstrate the totipotency of plant cells, and demonstration of how a gene can be switched on by, for example, the induction of β-galactosidase.

Opportunities for developing mathematical skills within this topic include using ratios, fractions and percentages, making order of magnitude calculations using decimal and standard form and using appropriate number of significant figures, understanding the terms mean, median and mode, constructing and interpreting frequency tables and diagrams, bar charts and histograms, and completing a statistical test. (Please see *Appendix 5: Mathematical skills and exemplifications* for further information.)

Students should:	
3.1	Know that all living organisms are made of cells, sharing some common features.
3.2	Know the ultrastructure of eukaryotic cells, including nucleus, nucleolus, ribosomes, rough and smooth endoplasmic reticulum, mitochondria, centrioles, lysosomes, and Golgi apparatus.
3.3	Understand the role of the rough endoplasmic reticulum (rER) and the Golgi apparatus in protein transport within cells, including their role in the formation of extracellular enzymes.
3.4	Know the ultrastructure of prokaryotic cells, including cell wall, capsule, plasmid, flagellum, pili, ribosomes, mesosomes and circular DNA.
3.5	Be able to recognise the organelles in 3.2 from electron microscope (EM) images.
3.6	Understand how mammalian gametes are specialised for their functions (including the acrosome in sperm and the zona pellucida in the egg).
3.7	Know the process of fertilisation in mammals, including the acrosome reaction, the cortical reaction and the fusion of nuclei.
3.8	i) Know that a locus (plural = loci) is the location of genes on a chromosome. ii) Understand the linkage of genes on a chromosome and sex linkage.
3.9	Understand the role of meiosis in ensuring genetic variation through the production of non-identical gametes as a consequence of independent assortment of chromosomes and crossing over of alleles between chromatids (details of the stages of meiosis are not required).

Students should:	
3.10	Understand the role of mitosis and the cell cycle in producing identical daughter cells for growth and asexual reproduction.
CORE PRACTICAL 5:	Prepare and stain a root tip squash to observe the stages of mitosis.
3.11	i) Understand what is meant by the terms 'stem cell, pluripotency and totipotency'. ii) Be able to discuss the way society uses scientific knowledge to make decisions about the use of stem cells in medical therapies.
3.12	Understand how cells become specialised through differential gene expression, producing active mRNA leading to synthesis of proteins, which in turn control cell processes or determine cell structure in animals and plants, including the lac operon.
3.13	Understand how the cells of multicellular organisms are organised into tissues, tissues into organs and organs into systems.
3.14	i) Understand how phenotype is the result of an interaction between genotype and the environment. ii) Know how epigenetic changes, including DNA methylation and histone modification, can modify the activation of certain genes. iii) Understand how epigenetic changes can be passed on following cell division.
3.15	Understand how some phenotypes are affected by multiple alleles for the same gene at many loci (polygenic inheritance) as well as the environment and how this can give rise to phenotypes that show continuous variation.

Topic 4: Biodiversity and Natural Resources

The topic focuses on biodiversity and the wealth of natural resources used by humans. Why there are so many different species is considered first, with the concept of niche and adaptation explored. The topic looks at how all this diversity has come about through adaptation and natural selection and how this leads to evolution. The concerns for disappearing biodiversity and loss of potential natural resources are used to highlight the need for biologists to identify, name and classify species. The topic has sections on both traditional and novel uses of plants and plant fibres and the use of chemical extracts from animals and plants. The relationship of plant anatomy to function and the structure and role of cellulose and starch is studied. The topic ends with the issue of sustainability and the role of zoos and seed banks in conservation of endangered species.

Students should be encouraged to carry out a range of practical experiments related to this topic in order to develop their practical skills. In addition to the core practicals detailed below possible experiments include investigation of the biodiversity of different habitats, investigation of taxonomic hierarchy using biological specimens, and examination of animal cells under the microscope and using electron micrographs.

Opportunities for developing mathematical skills within this topic include using ratios, fractions and percentages, calculate areas of circumferences and areas of circles and volumes of cylinders, substitute numerical values into algebric equations using appropriate units for physical quantities, solving algebraic equations and understand the principle of sampling as applied to scientific data. (Please see *Appendix 5: Mathematical skills and exemplifications* for further information.)

Students should:	
4.1	Know that over time the variety of life has become extensive but is now being threatened by human activity.
4.2	i) Understand the terms biodiversity and endemism. ii) Know how biodiversity can be measured within a habitat using species richness and within a species using genetic diversity by calculating the heterozygosity index (H): $H = \dfrac{\text{number of heterozygotes}}{\text{number of individuals in the population}}$ iii) Understand how biodiversity can be compared in different habitats using a formula to calculate an index of diversity (D): $D = \dfrac{N(N-1)}{\Sigma n(n-1)}$
4.3	Understand the concept of niche and be able to discuss examples of adaptation of organisms to their environment (behavioural, physiological and anatomical).
4.4	Understand how natural selection can lead to adaptation and evolution.

Students should:	
4.5	i) Understand how the Hardy-Weinberg equation can be used to see whether a change in allele frequency is occurring in a population over time. ii) Understand that reproductive isolation can lead to accumulation of different genetic information in populations potentially leading to the formation of new species.
4.6	i) Understand that classification is a means of organising the variety of life based on relationships between organisms using differences and similarities in phenotypes and in genotypes, and is built around the species concept. ii) Understand the process and importance of critical evaluation of new data by the scientific community, which leads to new taxonomic groupings, including the three domains of life based on molecular phylogeny, which are Bacteria, Archaea, Eukaryota.
4.7	Know the ultrastructure of plant cells (cell walls, chloroplasts, amyloplasts, vacuole, tonoplast, plasmodesmata, pits and middle lamella) and be able to compare it with animal cells.
4.8	Be able to recognise the organelles in 4.7 from electron microscope (EM) images.
4.9	Understand the structure and function of the polysaccharides starch and cellulose, including the role of hydrogen bonds between β-glucose molecules in the formation of cellulose microfibrils.
4.10	Understand how the arrangement of cellulose microfibrils and secondary thickening in plant cell walls contributes to the physical properties of xylem vessels and sclerenchyma fibres in plant fibres that can be exploited by humans.
CORE PRACTICAL 6:	Identify sclerenchyma fibres, phloem sieve tubes and xylem vessels and their location within stems through a light microscope.
4.11	Know the similarities and differences between the structures, position in the stem and function of sclerenchyma fibres (support), xylem vessels (support and transport of water and mineral ions) and phloem (translocation of organic solutes).
4.12	Understand the importance of water and inorganic ions (nitrate, calcium ions and magnesium ions) to plants.
CORE PRACTICAL 7:	Investigate plant mineral deficiencies.
CORE PRACTICAL 8:	Determine the tensile strength of plant fibres.
4.13	Understand the development of drug testing from historic to contemporary protocols, including William Withering’s digitalis soup, double blind trials, placebo, three-phased testing.
4.14	Understand the conditions required for bacterial growth.

Students should:	
CORE PRACTICAL 9:	Investigate the antimicrobial properties of plants, including aseptic techniques for the safe handling of bacteria.
4.15	Understand how the uses of plant fibres and starch may contribute to sustainability, including plant-based products to replace oil-based plastics.
4.16	Be able to evaluate the methods used by zoos and seed banks in the conservation of endangered species and their genetic diversity, including scientific research, captive breeding programmes, reintroduction programmes and education.

Assessment

Assessment summary

Summary of table of assessment

Students must complete both assessments in May/June in any single year.

Paper 1: Lifestyle, Transport, Genes and Health ***Paper code: 8BN0/01**	
• Questions draw on content from Topics 1 and 2. • Each question is set in a context. • Questions are broken down into a number of parts. • Availability: May/June • First assessment: 2016 • Each assessment is 1 hour 30 minutes. • Each assessment consists of 80 marks.	**50% of the total qualification**

Paper 2: Development, Plants and the Environment ***Paper code: 8BN0/02**	
• Questions draw on content from Topics 3 and 4. • Each question is set in a context. • Questions are broken down into a number of parts. • Availability: May/June • First assessment: 2016 • Each assessment is 1 hour 30 minutes. • Each assessment consists of 80 marks.	**50% of the total qualification**

The sample assessment materials can be found in the *Pearson Edexcel Level 3 Advanced Subsidiary GCE in Biology A (Salters-Nuffield) Sample Assessment Materials* document.

*See *Appendix 3: Codes* for a description of this code and all other codes relevant to this qualification.

Assessment Objectives and weightings

Students must:		% in GCE
AO1	Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures.	35-37
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.	41-43
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.	20-23
	Total	**100%**

Breakdown of Assessment Objectives

Paper	AO1	AO2	AO3	Total for all Assessment Objectives
Paper 1: Lifestyle, Transport, Genes and Health	17-19%	20-22%	10-12%	50%
Paper 2: Development, Plants and the Environment	17-19%	20-22%	10-12%	50%
Total for this qualification	**35-37%**	**41-43%**	**20-23%**	**100%**

Entry and assessment information

Student entry

Details of how to enter students for the examinations for this qualification can be found in our *UK Information Manual*. A copy is made available to all examinations officers and is available on our website at: www.edexcel.com/iwantto/Pages/uk-information-manual.aspx

Forbidden combinations and discount code

Centres should be aware that students who enter for more than one GCE qualification with the same discount code will have only one of the grades they achieve counted for the purpose of the School and College Performance Tables – normally the better grade (please see *Appendix 3: Codes*).

Students should be advised that if they take two qualifications with the same discount code, colleges, universities and employers are very likely to take the view that they have achieved only one of the two GCEs. The same view may be taken if students take two GCE qualifications that have different discount codes but have significant overlap of content. Students or their advisers who have any doubts about their subject combinations should check with the institution to which they wish to progress before embarking on their programmes.

Access arrangements, reasonable adjustments and special consideration

Access arrangements

Access arrangements are agreed before an assessment. They allow students with special educational needs, disabilities or temporary injuries to:

- access the assessment
- show what they know and can do without changing the demands of the assessment.

The intention behind an access arrangement is to meet the particular needs of an individual disabled student without affecting the integrity of the assessment. Access arrangements are the principal way in which awarding organisations comply with the duty under the Equality Act 2010 to make 'reasonable adjustments'.

Access arrangements should always be processed at the start of the course. Students will then know what is available and have the access arrangement(s) in place for assessment.

Reasonable adjustments

The Equality Act 2010 requires an awarding organisation to make reasonable adjustments where a person with a disability would be at a substantial disadvantage in undertaking an assessment. The awarding organisation is required to take reasonable steps to overcome that disadvantage.

A reasonable adjustment for a particular person may be unique to that individual and therefore might not be in the list of available access arrangements.

Whether an adjustment will be considered reasonable will depend on a number of factors, which will include:

- the needs of the student with the disability
- the effectiveness of the adjustment
- the cost of the adjustment; and
- the likely impact of the adjustment on the student with the disability and other students.

An adjustment will not be approved if it involves unreasonable costs to the awarding organisation, timeframes or affects the security or integrity of the assessment. This is because the adjustment is not 'reasonable'.

Special consideration

Special consideration is a post-examination adjustment to a student's mark or grade to reflect temporary injury, illness or other indisposition at the time of the examination/assessment, which has had, or is reasonably likely to have had, a material effect on a candidate's ability to take an assessment or demonstrate his or her level of attainment in an assessment.

Further information

Please see our website for further information about how to apply for access arrangements and special consideration.

For further information about access arrangements, reasonable adjustments and special consideration, please refer to the JCQ website: www.jcq.org.uk.

Malpractice

Candidate malpractice

Candidate malpractice refers to any act by a candidate that compromises or seeks to compromise the process of assessment or which undermines the integrity of the qualifications or the validity of results/certificates.

Candidate malpractice in examinations **must** be reported to Pearson using a *JCQ M1 Form* (available at www.jcq.org.uk/exams-office/malpractice). The form can be emailed to pqsmalpractice@pearson.com or posted to

Investigations Team, Pearson, 190 High Holborn, London, WC1V 7BH. Please provide as much information and supporting documentation as possible. Note that the final decision regarding appropriate sanctions lies with Pearson.

Failure to report malpractice constitutes staff or centre malpractice.

Staff/centre malpractice

Staff and centre malpractice includes both deliberate malpractice and maladministration of our qualifications. As with candidate malpractice, staff and centre malpractice is any act that compromises or seeks to compromise the process of assessment or which undermines the integrity of the qualifications or the validity of results/certificates.

All cases of suspected staff malpractice and maladministration **must** be reported immediately, before any investigation is undertaken by the centre, to Pearson on a *JCQ M2(a) Form* (available at www.jcq.org.uk/exams-office/malpractice). The form, supporting documentation and as much information as possible can be emailed to

pqsmalpractice@pearson.com or posted to Investigations Team, Pearson, 190 High Holborn, London, WC1V 7BH. Note that the final decision regarding appropriate sanctions lies with Pearson.

Failure to report malpractice itself constitutes malpractice.

More-detailed guidance on malpractice can be found in the latest version of the document *JCQ General and Vocational Qualifications Suspected Malpractice in Examinations and Assessments,* available at www.jcq.org.uk/exams-office/malpractice.

Equality Act 2010 and Pearson's equality policy

Equality and fairness are central to our work. Our equality policy requires all students to have equal opportunity to access our qualifications and assessments, and our qualifications to be awarded in a way that is fair to every student.

We are committed to making sure that:

- students with a protected characteristic (as defined by the Equality Act 2010) are not, when they are undertaking one of our qualifications, disadvantaged in comparison to students who do not share that characteristic
- all students achieve the recognition they deserve for undertaking a qualification and that this achievement can be compared fairly to the achievement of their peers.

You can find details on how to make adjustments for students with protected characteristics in the policy document *Access Arrangements, Reasonable Adjustments and Special Considerations*, which is on our website, www.edexcel.com/Policies.

Synoptic assessment

Synoptic assessment requires students to work across different parts of a qualification and to show their accumulated knowledge and understanding of a topic or subject area.

Synoptic assessment enables students to show their ability to combine their skills, knowledge and understanding with breadth and depth of the subject.

Awarding and reporting

This qualification will be graded, awarded and certificated to comply with the requirements of the current *Code of Practice* published by the Office of Qualifications and Examinations Regulation (Ofqual).

This qualification will be graded and certificated on a five-grade scale from A to E using the total subject mark. Individual papers are not graded.

The first certification opportunity for the Pearson Edexcel Level 3 Advanced Subsidiary GCE in Biology A (Salters-Nuffield) will be 2016.

Students whose level of achievement is below the minimum judged by Pearson Edexcel to be of sufficient standard to be recorded on a certificate will receive an unclassified U result.

Language of assessment

Assessment of this qualification will be available in English. All student work must be in English.

Other information

Student recruitment

Pearson follows the JCQ policy concerning recruitment to our qualifications in that:

- they must be available to anyone who is capable of reaching the required standard
- they must be free from barriers that restrict access and progression
- equal opportunities exist for all students.

Prior learning and other requirements

There are no prior learning or other requirements for this qualification.

Students who would benefit most from studying this qualification are likely to have a Level 2 qualification such as a GCSE in Additional Science or Biology.

Progression

Students can progress from this qualification to:

- a range of different relevant academic or vocational higher education qualifications
- employment in a relevant sector
- further training.

Relationship between Advanced Subsidiary GCE and Advanced GCE

The content for Advanced GCE in Biology A (Salters-Nuffield) includes all the content studied at Advanced Subsidiary GCE. The Advanced GCE in Biology A (Salters-Nuffield) builds on the knowledge, skills, and understanding achieved when studying the Advanced Subsidiary GCE in Biology A (Salters-Nuffield).

Progression from Advanced Subsidiary GCE to Advanced GCE

Students who have achieved the Advanced Subsidiary GCE in Biology A (Salters-Nuffield) can progress to the Advanced GCE in Biology A (Salters-Nuffield). They would have covered Topics 1-4 which are common to both qualifications but the additional topics 5-8 will need to be covered and then all the assessment for the Advanced GCE qualification must be taken at the end of the course.

Relationship between GCSE and Advanced Subsidiary GCE

Students cover Key Stage 4 fundamental core concepts in sciences at GCSE and continue to cover these concepts and additional subject material in the Advanced Subsidiary GCE at Key Stage 5.

Progression from GCSE to Advanced Subsidiary GCE

Students will draw on knowledge and understanding achieved in GCSE Additional Science or GCSE Biology to progress on to an Advanced Subsidiary GCE in Biology A (Salters-Nuffield) qualification.

Appendices

Appendix 1: Transferable skills

The need for transferable skills

In recent years, higher education institutions and employers have consistently flagged the need for students to develop a range of transferable skills to enable them to respond with confidence to the demands of undergraduate study and the world of work.

The Organisation for Economic Co-operation and Development (OECD) defines skills, or competencies, as 'the bundle of knowledge, attributes and capacities that can be learned and that enable individuals to successfully and consistently perform an activity or task and can be built upon and extended through learning.'[1]

To support the design of our qualifications, the Pearson Research Team selected and evaluated seven global 21st-century skills frameworks. Following on from this process, we identified the National Research Council's (NRC) framework as the most evidence-based and robust skills framework. We adapted the framework slightly to include the Program for International Student Assessment (PISA) ICT Literacy and Collaborative Problem Solving (CPS) Skills.

The adapted National Research Council's framework of skills involves:[2]

Cognitive skills

- **Non-routine problem solving** – expert thinking, metacognition, creativity.
- **Systems thinking** – decision making and reasoning.
- **Critical thinking –** definitions of critical thinking are broad and usually involve general cognitive skills such as analysing, synthesising and reasoning skills.
- **ICT literacy -** access, manage, integrate, evaluate, construct and communicate[3].

Interpersonal skills

- **Communication** – active listening, oral communication, written communication, assertive communication and non-verbal communication.
- **Relationship-building skills** – teamwork, trust, intercultural sensitivity, service orientation, self-presentation, social influence, conflict resolution and negotiation.
- **Collaborative problem solving** – establishing and maintaining shared understanding, taking appropriate action, establishing and maintaining team organisation.

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[1] OECD (2012), Better Skills, Better Jobs, Better Lives (2012): http://skills.oecd.org/documents/OECDSkillsStrategyFINALENG.pdf

2 Koenig, J. A. (2011) Assessing 21st Century Skills: Summary of a Workshop, National Research Council

3 PISA (2011) The PISA Framework for Assessment of ICT Literacy, PISA

Intrapersonal skills

- **Adaptability** – ability and willingness to cope with the uncertain, handling work stress, adapting to different personalities, communication styles and cultures, and physical adaptability to various indoor and outdoor work environments.
- **Self-management and self-development** – ability to work remotely in virtual teams, work autonomously, be self-motivating and self-monitoring, willing and able to acquire new information and skills related to work.

Transferable skills enable young people to face the demands of further and higher education, as well as the demands of the workplace, and are important in the teaching and learning of this qualification. We will provide teaching and learning materials, developed with stakeholders, to support our qualifications.

Appendix 2: Level 3 Extended Project qualification

What is the Extended Project?

The Extended Project is a standalone qualification that can be taken alongside GCEs. It supports the development of 21st-century independent learning skills and helps to prepare students for their next step – whether that be university study or employment. The qualification:

- is recognised by universities for the skills it develops
- is worth half of an Advanced GCE qualification at grades A* to E
- carries UCAS points for university entry.

The Extended Project encourages students to develop skills in the following areas: research, critical thinking, extended writing and project management. Students identify and agree a topic area of their choice (which may or may not be related to a GCE subject they are already studying), guided by their teacher.

Students can choose from one of four approaches to produce:

- a dissertation (for example an investigation based on predominately secondary research)
- an investigation/field study (for example a practical experiment)
- a performance (for example in music, drama or sport)
- an artefact (for example creating a sculpture in response to a client brief or solving an engineering problem).

The qualification is coursework based and students are assessed on the skills of managing, planning and evaluating their project. Students will research their topic, develop skills to review and evaluate the information, and then present the final outcome of their project.

Students: what they need to do

The Extended Project qualification requires students to:

- select a topic of interest for an in-depth study and negotiate the scope of the project with their teacher
- identify and draft an objective for their project (for example in the form of a question, hypothesis, challenge, outline of proposed performance, issue to be investigated or commission for a client) and provide a rationale for their choice
- produce a plan for how they will deliver their intended objective
- conduct research as required by the project brief, using appropriate techniques
- carry out the project using tools and techniques safely
- share the outcome of the project using appropriate communication methods, including a presentation.

Teachers: key information

- The Extended Project has 120 guided learning hours (GLH) consisting of:
    - a taught 40-GLH element that includes teaching the technical skills (for example research skills).
    - a guided 80-GLH element that includes mentoring students through the project work.
- Group work is acceptable, however it is important that each student provides evidence of their own contribution and produces their own report
- 100% externally moderated.
- Four Assessment Objectives: manage, use resources, develop and realise, review.
- Can be run over 1, 1½ or 2 years.
- Can be submitted in January or June.

How to link Extended Project with biology A (Salters Nuffield)

The Extended Project creates the opportunity to develop transferable skills for progression to higher education and to the workplace through the exploration of either an area of personal interest, or a topic of interest, from within the biology (Salters Nuffield) qualification content.

For example, biology students could choose to carry out an investigation that would enable them to develop their skills in data collection, the development and testing of hypotheses and the application of mathematical models in data analysis.

Skills developed

Through the Extended Project students will develop skills in the following areas.

- Independent research, including skills in primary research and the selection of appropriate methods for data collection.
- Extended reading and academic writing, including reading scientific literature and writing about trends or patterns in data sets.
- Planning/project management, including the refining of hypotheses to be tested in investigations.
- Data handling and evaluation, including the comparison of data from primary research with published data and exploration of the significance of results.
- Evaluation of arguments and processes, including arguments in favour of alternative interpretations of data and evaluation of experimental methodology.
- Critical thinking.

In the context of the Extended Project, critical thinking refers to the ability to identify and develop arguments for a point of view or hypothesis and to consider and respond to alternative arguments.

Using the Extended Project to support breadth and depth

There is no specified material that students are expected to study and, in the Extended Project, students are assessed on the quality of the work they produce and the skills they develop and demonstrate through completing this work. Students can use the Extended Project to demonstrate *extension* in one or more dimensions:

- ***deepening understanding***: where a student explores a topic in greater depth than in the specification content
- ***broadening skills***: the student learns a new skill. In a biology-based project, this might involve learning to assemble and manipulate an unfamiliar piece of apparatus or learning advanced data-handling techniques
- ***widening perspectives***: the student's project spans different subjects. This might involve discussing historical, philosophical or ethical aspects of a biology-based topic or making links with other subject areas such as chemistry or geography.

Choosing topics and narrowing down to a question

A dissertation, typically around 6000 words in length, involves addressing a research question through a literature review and argumentative discussion while an investigation/field study involves data collection and analysis, leading to a written report of around 5000 words.

For example, consider a student with an interest in genetic testing. After some initial research, the student decided to explore the risks and benefits associated with direct to consumer genetic testing. In the literature review of the project, the student researched the background to genetic testing and looked at the work of some of the companies which offer to do tests. The student created a questionnaire survey to elicit information about people's attitudes towards testing and their knowledge of the potential risks and benefits. The survey was piloted then repeated with a sample of 50 people. The student's data from this survey were compared with published data, and the trends and patterns in data analysed, with consideration of the significance of the results obtained. Finally, the student's project ended with a review of the effectiveness of the investigation and an oral presentation of the main findings and arguments considered.

Biology-based dissertation projects can cover a wide variety of topics, as these examples illustrate:

- Is it ethical to use stem cells for medical purposes?
- Should restrictions be placed on research into genetic enhancement?
- Is the use of animal experimentation justifiable?
- Is autism genetic?

Examples of Biology-based investigations include:

- Can changing owl behaviour be monitored through pellet studies?
- How has marina development affected local marshland biodiversity?
- Can pollution be effectively monitored by water quality in a local stream?
- Can monitoring a fitness programme help improve hurdling performance?

There is also scope for biology-based artefact Extended Projects. For example, a student might set out to design, make and test an item of apparatus. Extended Projects involving a performance can also be biology based. For example, a social issue relating to biology could be explored through drama.

Appendix 3: Codes

Type of code	Use of code	Code number
Discount codes	Every qualification is assigned to a discount code indicating the subject area to which it belongs. This code may change. Please go to our website (www.edexcel.com) for details of any changes.	For KS4 performance tables: RH3 For 16-18 performance tables: 1010
National Qualifications Framework (NQF) codes	Each qualification title is allocated an Ofqual National Qualifications Framework (NQF) code. The NQF code is known as a Qualification Number (QN). This is the code that features in the DfE Section 96 and on the LARA as being eligible for 16–18 and 19+ funding, and is to be used for all qualification funding purposes. The QN is the number that will appear on the student’s final certification documentation.	The QN for the qualification in this publication is: 601/5298/9
Subject codes	The subject code is used by centres to enter students for a qualification. Centres will need to use the entry codes only when claiming students’ qualifications.	Advanced Subsidiary GCE – 8BN0
Paper code	These codes are provided for reference purposes. Students do not need to be entered for individual papers.	Paper 1: 8BN0/01 Paper 2: 8BN0/02

Appendix 4: Working scientifically

Appendices 4 and 4a are taken from the document *GCE AS and A level regulatory requirements for biology, chemistry, physics and psychology* published by the DfE, April 2014. Working scientifically is achieved through practical activities.

Specifications in biology, chemistry and physics must encourage the development of the skills, knowledge and understanding in science through teaching and learning opportunities for regular hands-on practical work.

Skills identified in *Appendix 4a* are assessed in the written examinations.

Appendix 4a: Practical skills identified for indirect assessment and developed through teaching and learning

Question papers will assess the following student's abilities:

a) Independent thinking

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

b) 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

c) 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 for each science
- consider margins of error, accuracy and precision of data

d) 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 5: Mathematical skills and exemplifications

The information in this appendix has been taken directly from the document *GCE AS and A level regulatory requirements for biology, chemistry, physics and psychology* published by the Department for Education (April 2014).

In order to be able to develop their skills, knowledge and understanding in science, students need to have been taught, and to have acquired competence in, the appropriate areas of mathematics relevant to the subject as indicated in the table of coverage below.

The assessment of quantitative skills will include at least 10% level 2 or above mathematical skills for biology and psychology, 20% for chemistry and 40% for physics. These skills will be applied in the context of the relevant science A Level.

All mathematical content must be assessed within the lifetime of the specification.

The following tables illustrate where these mathematical skills may be developed and could be assessed in each of the sciences. Those shown in bold type would only be tested in the full A Level course.

This list of examples is not exhaustive. These skills could be developed in other areas of specification content.

	Mathematical skills	Exemplification of mathematical skill in the context of A Level biology (assessment is not limited to the examples given below)
(i) A.0 - arithmetic and numerical computation		
A.0.1	Recognise and make use of appropriate units in calculations	Candidates 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
A.0.2	Recognise and use expressions in decimal and standard form	Candidates 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}
A.0.3	Use ratios, fractions and percentages	Candidates 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)
A.0.4	Estimate results	Candidates may be tested on their ability to: • estimate results to sense check that the calculated values are appropriate
A.0.5	**Use calculators to find and use power, exponential and logarithmic functions**	**Candidates may be tested on their ability to:** • **estimate the number of bacteria grown over a certain length of time**

	Mathematical skills	Exemplification of mathematical skill in the context of A Level biology (assessment is not limited to the examples given below)
(ii) A.1 - handling data		
A.1.1	Use an appropriate number of significant figures	Candidates 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 be reported only to the limits of the least accurate measurement
A.1.2	Find arithmetic means	Candidates 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
A.1.3	Construct and interpret frequency tables and diagrams, bar charts and histograms	Candidates 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
A.1.4	Understand simple probability	Candidates may be tested on their ability to: • use the terms probability and chance appropriately • understand the probability associated with genetic inheritance
A.1.5	Understand the principles of sampling as applied to scientific data	Candidates may be tested on their ability to: • analyse random data collected by an appropriate means, e.g. calculate an index of diversity to compare the biodiversity of a habitat
A.1.6	Understand the terms mean, median and mode	Candidates 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

	Mathematical skills	Exemplification of mathematical skill in the context of A Level biology (assessment is not limited to the examples given below)
(ii) A.1 - handling data (continued)		
A.1.7	Use a scatter diagram to identify a correlation between two variables	Candidates may be tested on their ability to: • interpret a scattergram, e.g. the effect of life style factors on health
A.1.8	Make order of magnitude calculations	Candidates may be tested on their ability to: • use and manipulate the magnification formula $\text{magnification} = \dfrac{\text{size of image}}{\text{size of real object}}$
A.1.9	Select and use a statistical test	Candidates 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
A.1.10	Understand measures of dispersion, including standard deviation and range	Candidates 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
A.1.11	Identify uncertainties in measurements and use simple techniques to determine uncertainty when data are combined	Candidates may be tested on their ability to: • calculate percentage error where there are uncertainties in measurement
(iii) A.2 – algebra		
A.2.1	Understand and use the symbols: $=, <, <<, >>, >, \propto, \sim$.	No exemplification required.
A.2.2	Change the subject of an equation	Candidates may be tested on their ability to: • use and manipulate equations, e.g. magnification
A.2.3	Substitute numerical values into algebraic equations using appropriate units for physical quantities	Candidates may be tested on their ability to: • use a given equation e.g. a formula to calculate an index of diversity $D = \dfrac{N(N-1)}{\Sigma n(n-1)}$

	Mathematical skills	Exemplification of mathematical skill in the context of A Level biology (assessment is not limited to the examples given below)
A.2.4	Solve algebraic equations	Candidates may be tested on their ability to: • solve equations in a biological context, e.g. cardiac output = stroke volume x heart rate
A.2.5	**Use logarithms in relation to quantities that range over several orders of magnitude**	**Candidates may be tested on their ability to:** • **use a logarithmic scale in the context of microbiology, e.g. growth rate of a microorganism such as yeast**
(iv) A.3 – graphs		
A.3.1	Translate information between graphical, numerical and algebraic forms	Candidates 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
A.3.2	Plot two variables from experimental or other data	Candidates may be tested on their ability to: • select an appropriate format for presenting data, bar charts, histograms, graphs and scattergrams
A.3.3	Understand that $y = mx + c$ represents a linear relationship	Candidates 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
A.3.4	**Determine the intercept of a graph**	**Candidates may be tested on their ability to:** • **read off an intercept point from a graph, e.g. compensation point in plants**
A.3.5	Calculate rate of change from a graph showing a linear relationship	Candidates may be tested on their ability to: • calculate a rate from a graph, e.g. rate of transpiration
A.3.6	Draw and use the slope of a tangent to a curve as a measure of rate of change	Candidates 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

	Mathematical skills	Exemplification of mathematical skill in the context of A Level biology (assessment is not limited to the examples given below)
(v) A.4 - geometry and trigonometry		
A.4.1	Calculate the circumferences, surface areas and volumes of regular shapes	Candidates 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

Appendix 6: Command words used in examination papers

The following table lists the command words used in the external assessments.

Command word	Definition
Add/Label	Requires the addition or labelling to a stimulus material given in the question, for example labelling a diagram or adding units to a table.
Assess	Give careful consideration to all the factors or events that apply and identify which are the most important or relevant. Make a judgement on the importance of something, and come to a conclusion where needed.
Calculate	Obtain a numerical answer, showing relevant working. If the answer has a unit, this must be included.
Comment on	Requires the synthesis of a number of variables from data/information to form a judgement.
Compare and contrast	Looking for the similarities **and** differences of two (or more) things. Should not require the drawing of a conclusion. Answer must relate to both (or all) things mentioned in the question. The answer must include at least one similarity and one difference.
Complete	Requires the completion of a table/diagram.
Criticise	Inspect a set of data, an experimental plan or a scientific statement and consider the elements. Look at the merits and faults of the information presented and support judgements made by giving evidence.
Deduce	Draw/reach conclusion(s) from the information provided.
Describe	To give an account of something. Statements in the response need to be developed as they are often linked but do not need to include a justification or reason.
Determine	The answer must have an element which is quantitative from the stimulus provided, or must show how the answer can be reached quantitatively. To gain maximum marks there must be a quantitative element to the answer.
Devise	Plan or invent a procedure from existing principles/ideas.
Discuss	• Identify the issue/situation/problem/argument that is being assessed within the question • Explore all aspects of an issue/situation/problem/argument • Investigate the issue/situation etc by reasoning or argument

Command word	Definition
Draw	Produce a diagram either using a ruler or using freehand.
Evaluate	Review information then bring it together to form a conclusion, drawing on evidence including strengths, weaknesses, alternative actions, relevant data or information. Come to a supported judgement of a subject's qualities and relation to its context.
Explain	An explanation requires a justification/exemplification of a point. The answer must contain some element of reasoning/justification, this can include mathematical explanations.
Give/State/Name	All of these command words are really synonyms. They generally all require recall of one or more pieces of information.
Give a reason/reasons	When a statement has been made and the requirement is only to give the reasons why.
Identify	Usually requires some key information to be selected from a given stimulus/resource.
Justify	Give evidence to support (either the statement given in the question or an earlier answer)
Plot	Produce a graph by marking points accurately on a grid from data that is provided and then drawing a line of best fit through these points. A suitable scale and appropriately labelled axes must be included if these are not provided in the question.
Predict	Give an expected result.
Show that	Verify the statement given in the question.
Sketch	Produce a freehand drawing. For a graph this would need a line and labelled axis with important features indicated, the axis are not scaled.
State what is meant by	When the meaning of a term is expected but there are different ways of how these can be described.
Write	When the questions ask for an equation.

Appendix 7: Presentation by themes

Content

The learning outcomes for the AS/A level specification are organised below according to biological themes. This enables teachers to identify how the learning outcomes in the Topics link together as themes, should this approach be helpful.

Each learning outcome retains the same identifying topic sub references.

Learners will be expected to demonstrate and apply the knowledge, understanding and skills described in the content below. In addition, they will be expected to analyse, interpret and evaluate a range of scientific information, ideas and evidence using their knowledge, understanding and skills.

To demonstrate knowledge, learners should be able to undertake a range of activities including the ability to recall, describe and define, as appropriate. To demonstrate understanding, learners should be able to explain ideas and to use their knowledge to apply, analyse, interpret and evaluate, as appropriate.

There are opportunities for students to develop mathematical skills throughout the content. They are required to apply the skills to relevant chemistry contexts. Please see *Appendix 5: Mathematical skills and exemplifications*, for further information.

Topic 1: Lifestyle, Health and Risk

This topic builds on students' knowledge and understanding of the functioning of the circulatory system and the importance of lifestyle choices to health. The role of diet and other lifestyle factors in maintenance of good health is considered with particular reference to the heart and circulation and to cardiovascular disease (CVD). The structures and functions of some carbohydrates and lipids are also detailed within this context. Ideas about correlation, causation and the concept of risks to health are covered.

Students should be encouraged to carry out a range of practical experiments related to this topic in order to develop their practical skills. In addition to the core practicals detailed below possible experiments include heart dissection to relate heart structure to function, investigation of the structure blood vessels by measuring the elastic recoil of arteries and veins and by examining slides of blood vessels, measurement of blood pressure, and investigation of the hydrolysis of disaccharides.

Opportunities for developing mathematical skills within this topic include calculating probabilities, plotting two variables from experimental data, calculating % change, substituting numerical values into algebraic equations using appropriate units for physical quantities, constructing and interpreting frequency tables and diagrams, bar charts and histograms, translating information between graphical, numerical and algebraic forms and using scatter diagrams to identify a correlation between two variables. (Please see *Appendix 5: Mathematical skills and exemplifications* for further information.)

Students should:	
1.2	Understand the importance of water as a solvent in transport, including its dipole nature.
1.12	i) Know the difference between monosaccharides, disaccharides and polysaccharides, including glycogen and starch (amylose and amylopectin). ii) Be able to relate the structures of monosaccharides, disaccharides and polysaccharides to their roles in providing and storing energy (β-glucose and cellulose are not required in this topic).
1.13	Know how monosaccharides join to form disaccharides (sucrose, lactose and maltose) and polysaccharides (glycogen and amylose) through condensation reactions forming glycosidic bonds, and how these can be split through hydrolysis reactions.
1.14	i) Know how a triglyceride is synthesised by the formation of ester bonds during condensation reactions between glycerol and three fatty acids. ii) Know the differences between saturated and unsaturated lipids.
1.1	Understand why many animals have a heart and circulation (mass transport to overcome limitations of diffusion in meeting the requirements of organisms).
1.4	i) Know the cardiac cycle (atrial systole, ventricular systole and cardiac diastole) and relate the structure and operation of the mammalian heart, including the major blood vessels, to its function. ii) Know how the relationship between heart structure and function can be investigated practically.
1.3	Understand how the structures of blood vessels (capillaries, arteries and veins) relate to their functions.
CORE PRACTICAL 1:	Investigate the effect of caffeine on heart rate in *Daphnia*.
1.17	Discuss the potential ethical issues regarding the use of invertebrates in research.
1.6	Understand the blood-clotting process (thromboplastin release, conversion of prothrombin to thrombin and fibrinogen to fibrin) and its role in cardiovascular disease (CVD).
1.5	Understand the course of events that leads to atherosclerosis (endothelial dysfunction, inflammatory response, plaque formation, raised blood pressure).
1.7	Know how factors such as genetic, diet, age, gender, high blood pressure, smoking and inactivity increase the risk of cardiovascular disease (CVD).
1.18	Know the benefits and risks of treatments for cardiovascular disease (CVD) (antihypertensives, statins, anticoagulants and platelet inhibitors).
1.15	i) Be able to analyse and interpret data on the possible significance for health of blood cholesterol levels and levels of high-density lipoproteins (HDLs) and low-density lipoproteins (LDLs). ii) Know the evidence for a causal relationship between blood cholesterol levels (total cholesterol and LDL cholesterol) and cardiovascular disease (CVD).

Students should:	
1.16	Understand how people use scientific knowledge about the effects of diet including obesity indicators body mass index and waist-to-hip ratio, exercise and smoking to reduce their risk of coronary heart disease.
CORE PRACTICAL 2:	Investigate the vitamin C content of food and drink.
1.11	i) Be able to analyse data on energy budgets and diet. ii) Understand the consequences of energy imbalance, including weight loss, weight gain, and development of obesity.
1.8	Be able to analyse and interpret quantitative data on illness and mortality rates to determine health risks (including distinguishing between correlation and causation and recognising conflicting evidence).
1.9	Be able to evaluate the design of studies used to determine health risk factors including sample selection and sample size used to collect data that is both valid and reliable.
1.10	Understand why people's perceptions of risks are often different from the actual risks including underestimating and overestimating the risks due to diet and other lifestyle factors in the development of heart disease.

Topic 2: Genes and Health

This topic considers the following biological principles through the context of the genetic disease cystic fibrosis: the properties of and transport of materials, across cell membranes and gas exchange surfaces, DNA structure and replication, protein synthesis, enzymes and monohybrid inheritance through the context of the genetic disease cystic fibrosis. The topic also allows for discussion of the social and ethical issues surrounding the genetic screening for genetic conditions.

Students should be encouraged to carry out a range of practical experiments related to this topic in order to develop their practical skills. In addition to the core practicals detailed below possible experiments include investigation of the effect of surface are to volume ration on uptake by diffusion, examination of slides of alveoli to observe the features that aid diffusion into the bloodstream, and investigation of osmosis and diffusion across membranes, and investigate inheritance using, for example, corn ears.

Opportunities for developing mathematical skills within this topic include calculating areas of circumferences and areas of circles, surface areas and volumes of rectangular blocks and spheres, using ratios, fractions and percentages, plotting two variables from experimental or other data, determining the slope and intercepts of a linear graph, understand that y=mx+c represents a linear relationship, drawing and using the slope of a tangent to a curve as a measurement of rate of change, understanding simple probability and completing a statistical test. (Please see *Appendix 5: Mathematical skills and exemplifications* for further information.)

Students should:	
2.1	i) Know the properties of gas exchange surfaces in living organisms (large surface area to volume ratio, thickness of surface, difference in concentration). ii) Understand how the rate of diffusion is dependent on these properties and can be calculated using Fick's Law of Diffusion. iii) Understand how the structure of the mammalian lung is adapted for rapid gaseous exchange.
2.2	i) Know the structure and properties of cell membranes. ii) Understand how models such as the fluid mosaic model of cell membranes are interpretations of data used to develop scientific explanations of the structure and properties of cell membranes.
CORE PRACTICAL 3:	Investigate membrane structure, including the effect of alcohol concentration or temperature on membrane permeability.
2.3	Understand what is meant by osmosis in terms of the movement of free water molecules through a partially permeable membrane (consideration of water potential is not required).
2.4	i) Understand what is meant by passive transport (diffusion, facilitated diffusion), active transport (including the role of ATP as an immediate source of energy), endocytosis and exocytosis. ii) Understand the involvement of carrier and channel proteins in membrane transport.

Students should:	
2.5	i) Know the basic structure of mononucleotides (deoxyribose or ribose linked to a phosphate and a base, including thymine, uracil, cytosine, adenine or guanine) and the structures of DNA and RNA (polynucleotides composed of mononucleotides linked through condensation reactions). ii) Know how complementary base pairing and the hydrogen bonding between two complementary strands are involved in the formation of the DNA double helix.
2.6	i) Understand the process of protein synthesis (transcription) including the role of RNA polymerase, translation, messenger RNA, transfer RNA, ribosomes and the role of start and stop codons. ii) Understand the roles of the DNA template (antisense) strand in transcription, codons on messenger RNA and anticodons on transfer RNA.
2.7	Understand the nature of the genetic code (triplet code, non-overlapping and degenerate).
2.8	Know that a gene is a sequence of bases on a DNA molecule that codes for a sequence of amino acids in a polypeptide chain.
2.9	i) Know the basic structure of an amino acid (structures of specific amino acids are not required). ii) Understand the formation of polypeptides and proteins (amino acid monomers linked by peptide bonds in condensation reactions). iii) Understand the significance of a protein's primary structure in determining its three-dimensional structure and properties (globular and fibrous proteins and the types of bonds involved in its three-dimensional structure). iv) Know the molecular structure of a globular protein and a fibrous protein and understand how their structures relate to their functions (including haemoglobin and collagen).
2.10	i) Understand the mechanism of action and the specificity of enzymes in terms of their three-dimensional structure. ii) Understand that enzymes are biological catalysts that reduce activation energy. iii) Know that there are intracellular enzymes catalysing reactions inside cells and extracellular enzymes produced by cells catalysing reactions outside of cells.
CORE PRACTICAL 4:	Investigate the effect of enzyme and substrate concentrations on the initial rates of reactions.
2.11	i) Understand the process of DNA replication, including the role of DNA polymerase. ii) Understand how Meselson and Stahl's classic experiment provided new data that supported the accepted theory of replication of DNA and refuted competing theories.

Students should:	
2.12	i) Understand how errors in DNA replication can give rise to mutations. ii) Understand how cystic fibrosis results from one of a number of possible gene mutations.
2.13	i) Know the meaning of the terms: gene, allele, genotype, phenotype, recessive, dominant, incomplete dominance, homozygote and heterozygote. ii) Understand patterns of inheritance, including the interpretation of genetic pedigree diagrams, in the context of monohybrid inheritance.
2.14	Understand how the expression of a gene mutation in people with cystic fibrosis impairs the functioning of the gaseous exchange, digestive and reproductive systems.
2.15	i) Understand the uses of genetic screening, including the identification of carriers, pre-implantation genetic diagnosis (PGD) and prenatal testing, including amniocentesis and chorionic villus sampling. ii) Understand the implications of prenatal genetic screening.
2.16	Be able to identify and discuss the social and ethical issues related to genetic screening from a range of ethical viewpoints.

Topic 3: Voice of the Genome

This topic follows the development of multicellular organisms from single cells to complex individuals. Cell structure and ultrastructure, cell division, the importance of fertilisation, the roles of stem cells, gene expression, cell differentiation and tissue organisation are all considered within this topic, as is the role of the genotype, epigenetics and the effect of environment on phenotype.

Students should be encouraged to carry out a range of practical experiments related to this topic in order to develop their practical skills. In addition to the core practicals detailed below possible experiments include examination of animal cells under the microscope and using electron micrographs, plant tissue culture to demonstrate the totipotency of plant cells, and demonstration of how a gene can be switched on by, for example, the induction of β-galactosidase.

Opportunities for developing mathematical skills within this topic include using ratios, fractions and percentages, making order of magnitude calculations using decimal and standard form and using appropriate number of significant figures, understanding the terms mean, median and mode, constructing and interpreting frequency tables and diagrams, bar charts and histograms, and completing a statistical test. (Please see *Appendix 5: Mathematical skills and exemplifications* for further information.)

Students should:	
3.1	Know that all living organisms are made of cells, sharing some common features.
3.4	Know the ultrastructure of prokaryotic cells, including cell wall, capsule, plasmid, flagellum, pili, ribosomes, mesosomes and circular DNA.
3.2	Know the ultrastructure of eukaryotic cells, including nucleus, nucleolus, ribosomes, rough and smooth endoplasmic reticulum, mitochondria, centrioles, lysosomes, and Golgi apparatus.
3.5	Be able to recognise the organelles in 3.2 from electron microscope (EM) images.
3.3	Understand the role of the rough endoplasmic reticulum (rER) and the Golgi apparatus in protein transport within cells, including their role in the formation of extracellular enzymes.
3.13	Understand why the cells of multicellular organisms are organised into tissues, tissues into organs and organs into systems.
3.10	Understand the role of mitosis and the cell cycle in producing identical daughter cells for growth and asexual reproduction.
CORE PRACTICAL 5:	Understand how to prepare and stain a root tip squash to observe the stages of mitosis.
3.9	Understand the role of meiosis in ensuring genetic variation through the production of non-identical gametes as a consequence of independent assortment of chromosomes and crossing over of alleles between chromatids (details of the stages of meiosis are not required).

Students should:	
3.8	i) Know that a locus (plural = loci) is the location of genes on a chromosome. ii) Understand the linkage of genes on a chromosome and sex linkage.
3.6	Understand how mammalian gametes are specialised for their functions (including the acrosome in sperm and the zona pellucida in the egg).
3.7	Know the process of fertilisation in mammals, including the acrosome reaction, the cortical reaction and the fusion of nuclei.
3.11	i) Understand what is meant by the terms 'stem cell, pluripotency and totipotency'. ii) Be able to discuss the way society uses scientific knowledge to make decisions about the use of stem cells in medical therapies.
3.12	Understand how cells become specialised through differential gene expression, producing active mRNA leading to synthesis of proteins, which in turn control cell processes or determine cell structure in animals and plants including the lac operon.
3.14	i) Understand how phenotype is the result of an interaction between genotype and the environment. ii) Know how epigenetic changes (including DNA methylation and histone modification) can modify the activation of certain genes. iii) Understand how epigenetic changes can be passed on following cell division.
3.15	Understand how some phenotypes are affected by multiple alleles for the same gene at many loci (polygenic inheritance) as well as the environment and how this can give rise to phenotypes that show continuous variation.

Topic 4: Biodiversity and Natural Resources

The topic focuses on biodiversity and the wealth of natural resources used by humans. Why there are so many different species is considered first, with the concept of niche and adaptation explored. The topic looks at how all this diversity has come about through adaptation and natural selection and how this leads to evolution. The concerns for disappearing biodiversity and loss of potential natural resources are used to highlight the need for biologists to identify, name and classify species. The topic has sections on both traditional and novel uses of plants and plant fibres and the use of chemical extracts from animals and plants. The relationship of plant anatomy to function and the structure and role of cellulose and starch is studied. The topic ends with the issue of sustainability and the role of zoos and seed banks in conservation of endangered species.

Students should be encouraged to carry out a range of practical experiments related to this topic in order to develop their practical skills. In addition to the core practicals detailed below possible experiments include investigation of the biodiversity of different habitats, investigation of taxonomic hierarchy using biological specimens, and examination of animal cells under the microscope and using electron micrographs.

Opportunities for developing mathematical skills within this topic include using ratios, fractions and percentages, calculate areas of circumferences and areas of circles and volumes of cylinders, substitute numerical values into algebric equations using appropriate units for physical quantities, solving algebraic equations and understand the principle of sampling as applied to scientific data. (Please see *Appendix 5: Mathematical skills and exemplifications* for further information.)

Students should:	
4.1	Know that over time the variety of life has become extensive but is now being threatened by human activity.
4.2	i) Understand the terms biodiversity and endemism. ii) Know how biodiversity can be measured within a habitat using species richness and within a species using genetic diversity by calculating the heterozygosity index (H): $$H = \frac{\text{number of heterozygotes}}{\text{number of individuals in the population}}$$ iii) how biodiversity can be compared in different habitats using a formula to calculate an index of diversity (D): $$D = \frac{N(N-1)}{\Sigma n(n-1)}$$
4.3	Understand the concept of niche and be able to discuss examples of adaptation of organisms to their environment (behavioural, physiological and anatomical).
4.4	Understand how natural selection can lead to adaptation and evolution.

Students should:	
4.5	i) Understand how the Hardy-Weinberg equation can be used to see whether a change in allele frequency is occurring in a population over time. ii) Understand that reproductive isolation can lead to accumulation of different genetic information in populations potentially leading to the formation of new species.
4.6	i) Understand that classification is a means of organising the variety of life based on relationships between organisms using differences and similarities in phenotypes and in genotypes, and is built around the species concept. ii) Understand the process and importance of critical evaluation of new data by the scientific community, which leads to new taxonomic groupings, including the three domains of life based on molecular phylogeny, which are Bacteria, Archaea, Eukaryota.
4.7	Know the ultrastructure of plant cells (cell walls, chloroplasts, amyloplasts, vacuole, tonoplast, plasmodesmata, pits and middle lamella) and be able to compare it with animal cells.
4.8	Be able to recognise the organelles in 4.7 from electron microscope (EM) images.
4.9	Understand the structure and function of the polysaccharides starch and cellulose, including the role of hydrogen bonds between β-glucose molecules in the formation of cellulose microfibrils.
4.10	Understand how the arrangement of cellulose microfibrils and secondary thickening in plant cell walls contributes to the physical properties of xylem vessels and sclerenchyma fibres in plant fibres that can be exploited by humans.
CORE PRACTICAL 6:	Identify sclerenchyma fibres, phloem sieve tubes and xylem vessels and their location within stems through a light microscope.
4.11	Know the similarities and differences between the structures, position in the stem and function of sclerenchyma fibres (support), xylem vessels (support and transport of water and mineral ions) and phloem (translocation of organic solutes).
4.12	Understand the importance of water and inorganic ions (nitrate, calcium ions and magnesium ions) to plants.
CORE PRACTICAL 7:	Understand how to investigate plant mineral deficiencies practically.
CORE PRACTICAL 8:	Determine the tensile strength of plant fibres practically.
4.13	Understand the development of drug testing from historic to contemporary protocols, including William Withering's digitalis soup, double blind trials, placebo, three-phased testing.
4.14	Understand the conditions required for bacterial growth.

Students should:	
CORE PRACTICAL 9:	Investigate the antimicrobial properties of plants, including aseptic techniques for the safe handling of bacteria.
4.15	Understand how the uses of plant fibres and starch may contribute to sustainability, including plant-based products to replace oil-based plastics.
4.16	Be able to evaluate the methods used by zoos and seed banks in the conservation of endangered species and their genetic diversity, including scientific research, captive breeding programmes, reintroduction programmes and education.

Appendix 8: Support from the University of York

The Salters-Nuffield Advanced Biology (SNAB) project team in the University of York Science Education Group runs in-service courses for teachers from centres that are following, or preparing to follow, this qualification.

The project team also runs an advice service to help with questions concerning the teaching of the course. Teachers and technicians can join an email group for those following the course.

Centres following this qualification may be eligible for additional financial support (for example book grants) from the Salters Companies.

For further information about the SNAB course and about the support available to centres, please visit the SNAB project website:
www.york.ac.uk/education/projects/SNAB

or contact the project administrator:

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VAT Reg No GB 278 537121

ISBN 978-1-4469-3090-8