Contents

WJEC Advanced Subsidiary GCE in Biology
WJEC Advanced GCE in Biology

2007 & 2008

GCE BIOLOGY

Subject/Option Entry Codes	
Advanced Subsidiary (AS) "Cash in" entry *Advanced (A) "Cash in" entry*	*310 80* *005 890*
Unit BI1	311 01
Unit BI2	312 01
Unit BI3 (AS Practical Work)	313 01
Unit BI4	314 01
Unit BI5	315 01
Unit BI6 (A2 Practical Work)	316 01

When making entries, the codes listed should be prefixed with a '0' for English medium entries and with a 'W' for Welsh medium entries

Availability of Assessment Units		
Unit	**January**	**June**
BI1	✓	✓
BI2	✓	✓
BI3		✓
BI4	✓	✓
BI5		✓
BI6		✓

SUMMARY OF ASSESSMENT

ADVANCED SUBSIDIARY					
Assessment Unit	Content	Time for unit assessment	Marks Available	Weighting as a	
				% AS	% A
BI1	Fundamental concepts and organisation	1 hr 30 min	70	35	17.5
BI2	Adaptations and ecology	1 hr 30 min	70	35	17.5
BI3	Practical assessment	3 hrs 45 min	70	30	15.0

ADVANCED GCE (above 3 units plus the following)				
Assessment unit	Content	Time for unit assessment	Marks available	Weightings as a % A
BI4	Biochemistry and health	1 hr 40 min	75	15
BI5	A Variety and control B Synoptic assessment	2 hrs	56 34 } 90	20
BI6	Practical assessment Synoptic practical	4 hrs	35 35 } 70	15

All assessment units are externally set and assessed.

Assessment units BI1, BI2 and BI4 are available in January.

All assessment units are available in June.

Synoptic assessment is included in BI5 A (content based), BI5 B and BI6 at 5%, 6.5% and 7.5% weightings respectively.

BIOLOGY

1 *INTRODUCTION*

Criteria for GCE Advanced Subsidiary and Advanced GCE

This specification meets the General Criteria for GCE Advanced Subsidiary (AS) and Advanced (A) and the Subject Criteria for AS/A Biology issued by ACCAC/QCA (June 1999).

Both the Advanced Subsidiary and Advanced GCE qualifications will be reported on a five-grade scale of A, B, C, D and E. Candidates who fail to reach the minimum standard for grade E are recorded as U (unclassified), and do not receive a certificate. The level of demand of the Advanced Subsidiary examination is that expected of candidates half way through a full Advanced course.

The AS assessment units will have equal weighting with the second half of the qualification (A2) when these are aggregated to produce the Advanced award. AS and A2 will each consist of three assessment units, referred to in this specification as BI 1-3 and BI 4-6 respectively. This will allow candidates the opportunity to be assessed either in stages throughout the course, or for all assessments to be taken at the end of the course.

Recommended Prior Learning

Some prior knowledge of biological concepts is recommended. Prior learning from courses other than GCSE or from work based experience may provide a suitable foundation for this course of study.

Mathematical requirements are specified in the subject criteria and repeated in appendix 1 of this specification. It is recommended that, in addition, an understanding of some basic chemical concepts would be advantageous at the start of the course, although knowledge could be acquired during the teaching of the course.

It is recommended, therefore, that an understanding of the following terms is acquired before the end of the course: - ion, electron, atom, molecule, element, covalent bond, electrovalent bond, hydrogen bond, condensation reaction, hydrolysis, oxidation, reduction, pH, buffer, diffusion, solubility, partial pressure, along with an understanding of the electromagnetic spectrum and meaning of chemical formulae and the manipulation of chemical equations.

Prohibited combinations

There are no prohibited combinations of AS/A Biology with other WJEC AS/A specifications or advanced GNVQ at subject level.

Every specification is assigned to a national classification code indicating the subject area to which it belongs.

Centres should be aware that candidates who enter for more than one GCE qualification with the same classification code, will have only one grade (the highest) counted for the purpose of the School and College Performance Tables.

The classification code for this specification is 1010.

Overlaps

There are no overlaps with other WJEC AS/A specifications in science or advanced GNVQ at the overall subject level. However, some content is complementary between this specification and advanced GNVQ in Land and Environment, in Health and Social Care and in Science. The complementary content occurs in both mandatory and optional GNVQ units.

Candidates with Particular Requirements

Requests for consideration of special assessment requirements and special consideration should be submitted to the WJEC. The procedures operated by the WJEC comply with the Joint Forum regulations and guidance entitled 'Candidates with Special Assessment Needs'.

Rationale

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

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

The WJEC specification is intended to define a body of knowledge and skills which is considered essential to the study of biology at this level. It provides a broad view of all the major aspects of the subject and an appreciation of their interdependence. The breadth of study and updated content will enable the implications of modern biology to be appreciated and the importance of the role of these studies in understanding environmental, ethical and social issues and their implications. An understanding of scientific method as the means by which the body of scientific knowledge is increased and an enquiring and critical approach is to be fostered, including an awareness that different perceptions, predictions and interpretations may be applied according to context.

The practical work serves to illustrate and to promote an investigatory approach. The use of computer technology such as CD-Roms, the Internet and computer simulations is encouraged.

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

The broad objectives therefore are:

- to provide a broad factual base and skills
- to stimulate an interest in the subject
- to facilitate a critical appreciation of issues arising from the subject.

2 *AIMS*

The aims of the specification at AS and Advanced are, as cited in the subject criteria, as follows:

(a) to enable candidates to develop essential knowledge and understanding of concepts of biology, and the skills needed for the use of these in new and changing situations.

(b) to enable candidates to develop an understanding of scientific methods.

(c) to encourage candidates to be aware of advances in technology, including information technology, relevant to biology.

(d) to enable candidates to recognise the value and responsible use of biology in society.

(e) to encourage candidates to sustain and develop their enjoyment of, and interest in, biology and provide a stimulus for further reading.

In addition a further aim at Advanced is:-

(f) to enable candidates to show knowledge and understanding of facts, principles and concepts from different areas of biology and to make and use connections between them.

Additional aims of the specification are also:

(g) to provide a suitable foundation for the study of biology or related courses in further and higher education.

(h) to encourage candidates to develop the skills of collecting and analysing information and providing a suitable concise and coherent explanation or description.

(i) to stimulate candidates' interest in, and awareness of, the social, technological, environmental and economic impact of biology in present day society.

(j) to provide candidates not intending to study biology at a higher level with a useful and worthwhile course.

Progression

The specification builds on the knowledge, understanding and skills set out in the national curriculum Key Stage 4 programme of study for Double Science.

It has been designed to reflect changes in the national curriculum for science pre - 16 and to allow progression from GCSE Science courses.

The A2 part of the specification builds on and extends the requirements of the AS and opportunities for staged assessment allow candidates to defer decisions about progression from Advanced Subsidiary to the full Advanced qualification.

The specification provides a sound basis for progression to the further study of biology and related courses or for employment in a related area. Due to its breadth and variety it also provides a satisfying, interesting and relevant course, irrespective of age and so contributes towards life long learning, also providing a link with other subjects.

Spiritual, moral, ethical, social and cultural issues

The specification provides a framework and includes specific content through which individual courses may address spiritual, moral, ethical, social and cultural issues.

Specific relevant subject content includes:

1.6 Human genome project; gene therapy; genetic engineering; genetic fingerprinting.
2.4 Eutrophication; greenhouse effect; global warming.
2.6 Agricultural exploitation; pest control.
4.6 Incidence of disease; disease control.
4.8 Vaccination programmes; antibiotic overuse.
5.2 Evolution and natural selection; loss of biodiversity.
5.5 Cloning.
5.9 Effects of drugs.

Project work and individual study may serve to extend understanding of the issues in order that a balanced appreciation of the conflicts and dilemmas involved, may be encouraged.

The Welsh Dimension

The specification framework also allows the use of the Welsh context for course designers in Wales to draw on local examples and priorities, thereby allowing development of the curriculum Cymreig. This allows for the consideration of local sensitivities, views and difficulties and also reflects the possible differences in approach to solutions which take place in Wales. For instance, local interest in diseases such as emphysema (2.2) and conflicts between production and conservation (2.6) in agriculture.

A Welsh version specification is available, as are Welsh medium question papers, so contributing to Welsh medium provision. In addition, opportunities for the development of Key Skills is provided especially communication, either through the medium of English or Welsh.

Sensitive Issues

It should also be noted that some aspects of the specification may raise contentious issues e.g. evolution which should be treated with understanding.

In addition the inclusion of human infections and diseases in the specification may raise difficulties for individuals, particularly those with personal involvement e.g. genetic disorders, therefore a sensitive approach is required.

Relationship to other areas of study and the European dimension

The approach used in constructing the specification lends itself to the establishment of links with other areas of study particularly those involving economic and industrial understanding and environmental and health education. Many of the points listed above may also be used to illustrate the European dimension. For instance, the need for international co-operation with regard to issues such as pollution (2.4), exploitation of resources (2.6) and health (4.8). In addition, the need for co-operation between different scientific communities to further knowledge and research, as with the human genome project (1.6). Further co-operation is also needed to enforce recommendations such as the limiting of human cloning (5.5), in order that knowledge is used for the good of and approval of society.

The above approach conforms with the aspirations expressed in the 1988 Resolutions of the Council of the European Community and the Ministers of Education meeting within the Council, concerning the European dimension in education and environmental education, particularly those intended at the level of member states.

3 SPECIFICATION CONTENT

The following content specifies the knowledge, understanding and skills to be examined. It does not constitute a teaching programme. Required practical work has been cited. However, as practical and investigative work is an integral part of science, practical work should be carried out wherever possible.

The content includes the knowledge, understanding and skills cited in the AS and Advanced biology subject criteria as developed by the regulatory bodies, which is common to all AS and Advanced biology specifications.

Detailed teachers guidance notes are available which clarify the depth of treatment required.

Within each assessment unit the numbered content is specified in bold type with amplification in roman type.

Assessment Unit BI1: Fundamental Concepts and Organisation

Summary

Unit BI1 incorporates the biochemistry and structure which is fundamental to the functioning of living things: structure and function of biological compounds and enzymes; basic cell structure and organisation; cell division; cell membranes; membrane transport.

1.1 **Biological compounds contain a limited number of chemical elements. These are combined in small organic molecules which may be further linked to form very large molecules.**

(a) The main elements found in living organisms. Some elements are needed in trace amounts (details not required).
Key elements are present as inorganic ions: Mg^{2+}, Fe^{2+}, K^{+}, Na^{+}, Ca^{2+}, PO_4^{3-}, SO_4^{2-}, NO_3^{-}, Cl^{-}, HCO_3^{-}.
The importance of water in terms of its polarity, ability to form hydrogen bonds, surface tension, as a solvent, thermal properties, as a metabolite.

(b) Structure properties and functions of carbohydrates: monosaccharides (triose, pentose, hexose sugars); disaccharides (sucrose, lactose, maltose); polysaccharides (starch, glycogen, cellulose). Alpha and beta structural isomerism in glucose resulting in storage and structural carbohydrates as illustrated by starch and cellulose. Chemical properties enabling the use of starch and glycogen as storage and cellulose as structural compounds.

Structure, properties and functions of lipids as illustrated by triglycerides and phospholipids.
Lipids as an energy store.
Implications of saturated and unsaturated fat on human health.

Structure and role of amino acids and proteins. The peptide link.
Relation of molecular structure to function.
Primary, secondary, tertiary and quaternary structure of proteins.
Globular and fibrous proteins

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

Practical Activities: Iodine-Potassium iodide test for starch; Benedict's test for reducing and non-reducing sugars; biuret test for protein.

1.2 **The basis of biological organisation is the cell.**

(a) The internal membranes of eukaryotic cells and their importance.
The structure of the following organelles: mitochondria; endoplasmic reticulum (rough and smooth); ribosomes; golgi body; lysosomes; centrioles; chloroplasts; vacuoles; nucleus; chromatin; nuclear envelope; nucleolus; plasmodesmata.
The function of these organelles.
Structure of prokaryotic cells and viruses.
Comparison of the structure of animal, plant and prokaryote cells and viruses.

(b) Levels of organisation: aggregation of cells into tissues. Brief histology of: epitheluim, cuboidal and ciliated; muscle, smooth and striated; connective tissue, collagen. Aggregation of tissues into organs.

Practical Activities: The use of the light microscope. Calibration of microscope using a stage micrometer and eye piece graticule. Use of the units mm and μm. Measurement using microscope. Calculation of the magnification of drawings. Examination of a range of living cells e.g. *Spirogyra*, onion epidermis, *Elodea* cells, potato tuber cells. Temporary preparations using simple materials e.g. iodine in potassium iodide, methylene blue, dilute glycerine.
Examination of slides showing: epithelia, muscle, collagen.
A study of a range of electron micrographs of prokaryote and eukaryote cells to show structure.

1.3 **Living cells take up nutrients and other requirements, secrete chemicals and communicate with each other. The boundary of the cell has unique properties which permit these diverse activities.**

(a) The principal components of the plasma membrane and the fluid mosaic model. Factors affecting permeability of the membrane.

(b) Transport mechanisms: diffusion and factors affecting the rate of diffusion, osmosis and water potential, pinocytosis, facilitated diffusion, phagocytosis, secretion (exocytosis), active transport and influence of cyanide.

Practical activities: Determination of water potential by measuring changes in mass, and solute potential by measuring the degree of incipient plasmolysis.

1.4 **Most biological reactions are regulated by enzymes.**

(a) Metabolism is a collection of enzyme controlled reactions.
The protein nature of enzymes. Enzymes may act intracellularly or extracellularly. (ref to 1.2, 1.6)
Active sites interpreted in terms of three dimensional structure, theory of induced fit as illustrated by lysozyme.

(b) The meaning of catalysis; the lowering of the activation energy. Influence of temperature, pH, substrate and enzyme concentration on rate of activity. Inactivation and denaturation.
Functions of the following enzymes in the human alimentary canal: salivary amylase, rennin, pepsinogen/pepsin, trypsinogen/trypsin, enterokinase, lipase.
Physiological significance of the effects of temperature, pH, activation, inactivation on digestive enzymes.

(c) The principles of competitive and non competitive inhibition (references to reversible and irreversible action not required) as illustrated by succinic dehydrogenase and potassium cyanide.
End product inhibition.

Practical Activities: Investigations into the effect of enzyme and substrate concentrations on enzyme activity. The importance of buffers for maintaining a constant pH.
Investigation into the immobilisation of enzymes e.g. pectinase.

1.5 **Medical and industrial applications of enzymes.**

(a) Biosensors and their use giving rapid, accurate and sensitive diagnosis in medicine as illustrated by glucose oxidase testing of blood for diabetes.

(b) The importance of immobilised enzymes. Industrial processes utilise immobilised enzymes enmeshed in an inert solid support so allowing enzyme reuse and improving stability.

1.6 **The nature of the genetic code and how it determines the nature of organisms.**

(a) Structure of nucleotides (pentose sugar, phosphate, organic base) as illustrated by ATP and as subunits of nucleic acids.
Structure of nucleic acids: DNA bases: purines-adenine and guanine, pyrimidines-cytosine and thymine, complementary base pair rule, hydrogen bonding and the double helix (triple and double bonding not required), antiparallel strands.
Comparison between the structure of RNA and DNA.

(b) The two major functions of DNA: replication and protein synthesis.
The semi-conservative replication of DNA catalysed by DNA polymerase.
Evidence from Meselson and Stahl experiment.
The genetic code. The triplet code for amino acids.

(c) The transcription of DNA to produce messenger RNA.
Translation by ribosomes and transfer RNA, which has an anticodon and a specific amino acid binding site, to synthesize proteins (other details of the structure of tRNA not required).

'One gene - one polypeptide' hypothesis.
Polypeptides may be further modified and combined.

(d) There is an international project sequencing the genetic code of human chromosomes.
Access http://www.ncbi.nlm.nih.gov/SCIENCE 96/
The potential uses, disease treatment, and abuses of this human genome project such as eugenics, false hopes of cure for disease, genes as a predictor of health.

A risk, difficulty and advantage of using gene therapy for the treatment of disease as illustrated by cystic fibrosis. Use of liposomes to insert the new DNA fragment.

Formation of recombinant DNA by insertion of foreign DNA into bacterial plasmids and cloning of the bacteria to produce useful molecules as illustrated by insulin.
The use of restriction endonuclease, DNA ligase, reverse transcriptase, antibiotic marker gene.
Advantages and disadvantages of genetic engineering.
Issues associated with genetically modified food crops such as tomatoes and soya.

Genetic fingerprinting of an individual produces a unique pattern of bands of DNA.
Uses of this technique.

1.7 **Genetic information is copied and passed on to daughter cells.**

(a) Interphase (no subdivisions required). Significance of mitosis as a process in which daughter cells are provided with identical copies of genes. Main stages of mitosis. The importance of meiosis and fertilisation in sexual reproduction giving rise to variation. Main stages of meiosis (names of subdivisions of prophase 1 not required). Cytokinesis in animal cells.

(b) Advantages and disadvantages of sexual and asexual reproduction.

Practical activities: Observation of prepared slides of root tip for mitosis and developing anthers for meiosis.

Assessment Unit BI2: Adaptations and Ecology

Summary

Unit BI2 incorporates the study of adaptations within the living world and the interdependence of the various organisms in ecosystems: adaptations for exchange of materials especially respiratory gases; transport systems; energy flow through ecosystems; human effects on the environment.

2.1 **All organisms need transport systems. This requirement increases with increasing size and complexity.**

(a) Unicellular organisms. Diffusion. High surface to volume ratios.
(b) Multicellular organisms. Decreasing surface to volume ratio and division of labour in cells. Properties to aid uptake and supply of requirements.
Development of exchange surfaces and transport systems.

2.2 **Gas exchange is an essential feature of organisms.**

(a) Species are adapted to survive in particular environmental conditions.

The influence of size and environmental conditions on the exchange of gases as illustrated by *Amoeba*, earthworm, bony fish.
The importance of counter current flow and ventilation movements in the bony fish.

The structure and function of human breathing system to include: epiglottis, trachea, bronchi, bronchioles, alveoli, pleural membranes, ribs, intercostal muscles, diaphragm. Ventilation movements including role of intercostal muscles, diaphragm, pleural membranes and pleural cavity and exchange of gases in alveoli. Role of surfactant.
Principles of spirometry and lung capacities including interpretation of data (practical work not required).
Effects of pulmonary disorders on lung function as illustrated by asthma and emphysema.

(b) Structure of the angiosperm leaf to include: cuticle, epidermis, palisade mesophyll, spongy mesophyll, vascular bundle, air space, stomata, guard cells. The role of these structures in allowing the plant to photosynthesise effectively. The leaf as an organ of gaseous exchange; intercellular spaces. Stomatal opening and closing. Xerophytes may open stomata at night.

Practical Activities: Examination of epidermal strips and/or replicas. T.S. dicotyledonous leaf, *Ligustrum* (Privet). Examination of fish gill.

2.3 **Substances are transported from and to exchange surfaces.**

(a) Structure of root of dicotyledon. Absorption of water.
Movement through the root, apoplast and symplast, structure and role of endodermis. The structure of xylem. Movement of water from root to leaf.
Transpiration, cohesion-tension theory to describe the transpiration stream. Environmental factors affecting transpiration. Xerophytic adaptations as illustrated by marram grass.

Active uptake of mineral ions and their movement in the transpiration stream.

The structure of phloem as seen by light and electron microscope.
Translocation of organic materials from source to sink. Phloem transport: diffusion; cytoplasmic strands; mass flow models.

Practical Activities: Examination of T.S. dicotyledon primary stem and root. T.S. and L.S. of primary xylem and phloem. T.S. marram grass leaf. The use of a simple potometer.
Computer modelling may be used to extend this investigation.

(b) The circulatory system in human. The names of the main blood vessels associated with the heart. Structure of heart, artery, vein and capillary in relation to functions. The cardiac cycle and the maintenance of circulation to include graphical analysis of pressure changes. Role of sinoatrial node and Purkinje fibres.

The function of red blood cells and plasma in relation to transport of respiratory gases, dissociation curves of haemoglobin of mammal (adult and fetus) and llama. Böhr effect and chloride shift. Transport of nutrients, hormones, excretory products and heat.

The formation of tissue fluid and its importance in exchange. Excess fluid drains into the lymphatic system. The effect of low blood proteins on capillary filtration resulting in oedema as illustrated by kwashiorkor.

Practical Activities: Examination of T.S. of artery and vein. Observation of erythrocytes and leucocytes in prepared blood smears.

2.4 **There is a continuous transfer of energy and materials between organisms.**

(a) The concept of ecosystems. The sun is the source of energy for the ecosystem. The concept of habitat and community. Transfer of energy from plants to animals. Trophic levels and the efficiency of energy transfer. Gross and net production.

The differences between autotrophic and heterotrophic methods of nutrition. Modes of heterotrophic nutrition: holozoic, herbivores, carnivores, omnivores; detritivores; parasites and saprophytes. Pyramids of number, biomass and energy

(b) Food chains and food webs. The importance of organic breakdown in recycling nutrients.
The nitrogen cycle with bacteria referred to as nitrifying, denitrifying and nitrogen fixing (species names not required). Significance of nitrates in proteins and nucleic acids.
The importance of ploughing and drainage in producing the aerobic conditions needed for nitrification.
The carbon cycle.
Eutrophication and algal blooms.
Greenhouse effect and global warming.

2.5 **The supply of nutrients is only one of the factors controlling population size.**

(a) Populations and the way in which they grow - a simple quantitative treatment.
Immigration, emigration, birth and death rates.
Graphs showing population growth.
Factors affecting population growth: weather, predation, parasitism, food supply, living space, competition, carrying capacity.
Distinguish between factors which slow growth and those which cause a population crash.
Regulation by density dependent and density independent factors.

(b) Principles of succession as illustrated by the change from bare rock to woodland.
Use of terms primary and secondary succession, pioneers, sere and climax community.

2.6 **Human activities can impose far reaching effects on the environment.**

(a) Agricultural exploitation. Conflicts between production and conservation as illustrated by:

1. forests: reasons for forest destruction, consequences, managed forests.
2. oceans: the problems of over-fishing and attempts at regulation as illustrated by the principle of quotas, exclusion zones and restricted net mesh size.

(b) The principles of chemical and biological control of pests and their relative advantages and disadvantages,
The use of pyrethroids to control pest insects in agriculture and the parasite *Encarsia formosa* to control the glasshouse white fly *Trialeuroides vaporariorum*.
The effects of human activities on the carbon cycle. Economic importance of the nitrogen cycle in relation to food production and fertiliser application.

Assessment Unit BI3: Practical work

Details given under scheme of assessment. Content based on BI1 and BI2.

Assessment Unit BI4: Biochemistry and Health

Summary

Unit BI4 involves the study of energy supply in living organisms along with microbiology and disease: respiration; photosynthesis; uptake of energy and nutrients; microorganisms and disease; disease control; defence mechanisms.

4.1 **Energy is essential for the maintenance of living systems.**

(a) The importance of chemical energy in biological processes.
The central role of ATP as an energy carrier and its use in the liberation of energy for cellular activity.

(b) The synthesis of ATP by means of a flow of protons through the enzyme ATP synthetase.
The similarity between mitochondrial and chloroplast membrane function in providing a proton gradient for ATP synthesis.

(c) The maintenance of the proton gradient by proton pumps driven by electron energy. The alternate arrangement of pumps and electron carriers to form the electron transport chain. (Names of proton pumps and electron carriers in the electron transport system are **not** required).

4.2 **Respiration releases chemical energy from organic molecules in order to synthesize ATP for the maintenance of life.**

(a) All living organisms carry out respiration in order to provide energy in the cell.
The role of reduced NAD as a source of electrons and protons for the electron transport system.

(b) The Krebs cycle as a means of liberating energy from carbon bonds to provide ATP and reduced NAD with release of carbon dioxide.

(c) Glycolysis as a source of triose phosphate, pyruvate, ATP and reduced NAD. The formation of acetyl CoA.
(The names of glycolysis and other Krebs cycle intermediates are **not** required.)

(d) The energy budget of the breakdown of glucose under aerobic and anaerobic conditions.

Fat and amino acid utilisation in respiration as illustrated by long distance running and starvation.

Practical Activities: Demonstration of dehydrogenase activity using artificial hydrogen acceptors, as illustrated by methylene blue or DCPIP or tetrazolium compounds.

4.3 **Photosynthesis uses light energy to synthesize organic molecules.**

(a) The distribution of chloroplasts in relation to light trapping.
Chloroplasts as transducers converting the energy of light photons into the chemical energy of ATP.
Light harvesting. Absorption of various wavelengths of light by chlorophyll and associated pigments and energy transfer to reaction centres.

(b) Basic features of Photosystems I and II.
Cyclic and non-cyclic photophosphorylation sources of electrons for the electron transport chain. Loss of electrons as a form of oxidation. The hydroxide ion as a source of electrons for Photosystem II.

Reduction of NADP by addition of electrons and hydrogen ions; occurs in the stroma maintaining the proton gradient.

(c) The light independent stage and the formation of glucose; uptake of carbon dioxide by ribulose bisphosphate to form glycerate 3-phosphate.
Reduction of glycerate 3-phosphate to triose phosphate (carbohydrate), with the regeneration of ribulose bisphosphate.

Reduced NADP as a source of reducing power and ATP as a source of energy for these reactions.

Other carbohydrates, lipids and amino acids can be made from the triose phosphate. (No details of chemistry of these processes needed).

(d) The effect of light, carbon dioxide concentration and temperature on the rate of photosynthesis.
The concept of limiting factors.
The role of inorganic nutrients in plant metabolism as illustrated by the utilisation of nitrogen and magnesium.

Practical Activities: Separation of chloroplast pigments by chromatography.
A quantitative investigation of the effects of different coloured/wavelength light on the rate of photosynthesis. Computer modelling may be used to extend this investigation.

4.4 **The uptake of energy and nutrients.**

(a) Structure and function of the human alimentary canal. Histological structure of the ileum. Mechanical breakdown in the mouth and stomach.
The role of the secretions of the mouth, stomach, liver, pancreas and small intestine in digestion. (link with 1.4)
Peristalsis.

(b) Products of digestion and absorption, transport to the liver, deamination and storage of glycogen. (Reference to the control of digestive juice secretion is **not** required.)

Fat absorption as fatty acids and glycerol into lacteal, through lymphatic system to blood stream.

Practical Activities: Examination of T.S. ileum.

4.5 **Basic microbiology and disease**

(a) Bacteria may be grouped according to their shape (cocci/round, bacilli/rods and spiral) and by their reaction to the Gram stain.

Culture of microorganisms in the laboratory. Conditions necessary for growth; suitable temperature, water, pH, nutrient supply and oxygen level. Principles of aseptic techniques and use of sterile equipment.

Practical Activities: Examination of bacteria in order to recognise bacilli and cocci. Safe handling using aseptic technique. Use of simple stains e.g. methylene blue for staining bacteria (from milk) and examination using the light microscope.
Gram staining and microscopic investigation of yoghurt.

Principles underlying a simple batch culture fermenter.

(b) Counting microorganisms to monitor population growth, viable count, using serial dilutions, plating and counting colonies.

Practical Activities: Investigation into the numbers of bacteria in fresh and stale milk, using techniques of serial dilution, plating and counting colonies.

4.6 **Pathogens, spread of human disease and control of infection.**

(a) Pathogens are organisms which cause disease in a favourable host tissue.
Meaning of the following terms: infectious disease, carrier, animal reservoir, endemic, epidemic, vaccine, antibiotic, resistance, vector, toxin, antigenic(sero) types.

The causative organism, tissue affected and symptoms (in brief), source of infection, mode of transmission, prevention and control methods, including vaccines, for the following diseases:
Salmonellosis;
Cholera;
Influenza;

Malaria: Main stages (names of stages not required) of the life cycle of *Plasmodium* (parasite in salivary gland of mosquito, passes into blood stream when mosquito bites, invades liver cells, invades red blood cells, taken in when mosquito bites, passes to salivary gland) to illustrate suitable points at which the cycle can be broken by preventing transmission, controlling life cycle of vector. Advantages and disadvantages of control methods of Malaria.

(b) Treatment: antibiotics may be bacteriostatic or bactericidal and act on bacteria by interfering with specific metabolic pathways, as exemplified by penicillin acting on cell wall formation in Gram positive bacteria. Viruses are not susceptible to antibiotics. Plasmodium is susceptible to some drug treatment when outside cells in the blood stream.

4.7 **Human defence mechanisms**

(a) Natural barriers against infection. Influence of vitamin C and natural skin flora.
Localised defence by inflammation.
Immune responses as a result of foreign antigens.
Humoral and cell mediated immunity.
Antigen-antibody interactions; the role of T lymphocytes and B lymphocytes.

(b) Medically induced immunity which may be active, as illustrated by Rubella or passive as illustrated by Rabies.

4.8 **Applications and contemporary issues.**

(a) Industrial application of a batch culture fermenter as exemplified by penicillin production.

Applications of monoclonal antibodies as illustrated by pregnancy testing kits and drug targetting.

(b) Problems of antibiotic resistance, due to over use.
Relative effectiveness of vaccination programmes, as illustrated by the eradication of smallpox and the continued epidemics of influenza.
Ethical considerations for vaccination programmes.

Assessment Unit BI5: Variety and Control

Summary

Unit BI5 involves the study of variation and evolution plus sensitivity: reproduction; variation; genetics; evolution and diversity; homeostasis; nervous system.

5.1 **All organisms are variable in form and function.**

(a) Alleles as different forms of the same gene.
An understanding of the principles of monohybrid and dihybrid Mendelian inheritance. Codominance (Monohybrid only).
Sex linkage as illustrated by haemophilia.

(b) Gene mutation as illustrated by sickle cell anaemia and chromosome mutation as illustrated by Down's syndrome. Mutagens and carcinogens.
Random assortment, crossing over and fertilisation as sources of variation.

Practical Activities: One experiment to illustrate gene segregation (*Drosophila*, maize cobs and tomato plants are suitable, but other material may be used).

5.2 **Genetic variation is the raw material for evolutionary change.**

(a) Genetic and environmental factors produce variation between individuals.
Variation - continuous and discontinuous; heritable and non-heritable.

Practical Activities: Investigation of continuous variation in a locally occurring species including use of students t test e.g. comparison of florets on north and south facing Ivy or wing length in fruits of Sycamore (t test will only be examined through the practical assessment).

Inter and intra-specific competition for breeding success and survival.
Selective agencies (e.g. supply of food, breeding sites, climate).

The gene pool and genetic drift.
Selection can change the frequency of alleles in a population.

(b) Isolation and speciation.
Separation of populations by geographical, behavioural, morphological seasonal and isolation mechanisms. Hybrid sterility.
Darwin's theory of evolution that existing species have arisen through modification of ancestral species by natural selection.
The formation of new species as illustrated by Darwin's finches. Ancestral species evolved by adaptive radiation to occupy vacant niches, free from competition, in the Galapagos islands.

(c) Human influence on the environment has created new selection pressures as illustrated by warfarin resistance in rats, and antibiotic resistant forms of bacteria. Artificial selection.

Biodiversity. Reasons for species becoming endangered and causes of extinction. The conservation of gene pools in the wild and in captivity.

Practical Activities: Investigation of endangered species using secondary sources (ICT is suitable).

5.3 **Sexual reproduction is of major importance for plant productivity.**

(a) The generalised structure of wind, *Lolium* (ryegrass) and insect, *Primula* (primrose) pollinated flowers.
The development of pollen and ovules.
Pollination and self pollination.
Cross pollination as illustrated by *Primula*. Advantages and disadvantages.
Fertilisation. Double fertilisation.

(b) Formation of seed and fruit. Structure and germination of *Vicia faba* (broad bean).

Practical Activities: Dissection/examination of wind and insect-pollinated flowers. Examination of prepared slides of anthers, ovaries and developing fruits e.g. *Capsella* (Shepherds purse).
Starch agar diffusion technique to illustrate amylase action from cut surfaces of germinating bean.

5.4 **Sexual reproduction in human.**

(a) The structure and function of the reproductive systems in human.
Spermatogenesis and oogenesis to produce spermatozoa and secondary oocyte.
Sexual intercourse, fertilisation and implantation.

(b) Endocrine control, of reproduction in the female, menstrual cycle, birth and lactation by reference to follicle stimulating hormone, luteinizing hormone, oestrogen, progesterone, oxytocin and prolactin. Role of the placenta including hormonal control.
Endocrine control of reproduction in the male: luteinising hormone, testosterone.
Human chorionic gonadotrophin production by the embryo and its use in pregnancy detection tests.

Practical Activities: Histology of the ovary and testis.

5.5 **Applications of reproduction and genetics.**

The principles involved in cloning as illustrated by: separating cells of developing animal embryos, nuclear transplants from somatic cells into egg cells, tissue cultures of animals, micropropagation of plants. The advantages and disadvantages.

5.6 **Species are classified into groups using shared derived features.**

(a) Characteristic features of Kingdoms:-
Prokaryotae, Protoctista, Plantae, Fungi, Animalia.

(b) The concept of the species. The binomial system. The principle that modern classification should reflect closeness of evolutionary relations. The example of the Tiger should be used simply to illustrate the **concept** of each taxon and main features only.
Kingdom: Animalia; Phylum: Chordata; Class: Mammalia; Order: Carnivora; Family: Felidae; Genus: Panthera; Species: *P. tigris*.

5.7 **Control systems co-ordinate and regulate life processes.**

(a) The concept of homeostasis and its importance in maintaining the body in a state of dynamic equilibrium.
The role of negative feedback in restoring conditions to their original levels.

(b) Structure of the mammalian kidney including nephron. Adaptations of the cells of the proximal tubule for reabsorption.
Functions of the mammalian kidney including nitrogenous excretion and water regulation. Adaptations of the loop of Henlé to different environments.
Endocrine glands contribute to homeostatic balance as illustrated by the role of the posterior pituitary gland in the secretion of antidiuretic hormone.
The role of antidiuretic hormone.

Practical Activities: Gross low power study of prepared slides of the kidney.

5.8 **All living organisms show responses to stimuli which increase the chance of survival.**

Responding to a stimulus requires information from a receptor to be relayed to an effector.

Some animals have developed complex structures for the reception of stimuli. The ear, structure and function, for receiving, amplifying and transducing sound waves into electrical impulses for interpretation by the brain. (The ear as an organ of balance is not required).

5.9 **The structure of the nervous system of mammals permits a rapid transmission and processing of information.**

(a) The structure of the motor neurone, to include drawing and labelling of diagram.
The nature of the nerve impulse and the way it is transmitted: resting potential; membrane depolarisation and the action potential; 'all or nothing' law; refractory period; passage of sodium and potassium ions. Analysis of oscilloscope traces.
The structure and role of the synapse and synaptic transmission.
Chemicals such as organophosphates and psychoactive drugs (in brief) affect transmission.

(b) The structure of the human brain - the position of the cerebral hemispheres, hypothalamus, cerebellum, medulla oblongata.
The main functions of the cerebellum, medulla oblongata, hypothalamus.

The hypothalamus is the link between nervous and endocrine regulation.

(c) Voluntary actions involve coordination by the cerebral hemispheres and relay of information through the spinal cord.
The main areas of the spinal cord: central canal, grey matter, white matter.
The basic pattern of spinal nerves in relation to the spinal cord. Dorsal root and ventral root.
The simple reflex arc as the basis for protective, involuntary actions.
Flexion of the arm in response to a hot surface.

(d) Effectors are either muscles or glands.
Structure and ultra structure of skeletal muscle.
Sliding filament theory to include actin, myosin and actomyosin only.

Practical Activities: Examination of T.S. of spinal cord. The histology of skeletal muscle. Examination of electron micrographs of skeletal muscle.

Assessment Unit BI6: Practical work

Details given under scheme of assessment. Content based on BI4 and BI5.

4 KEY SKILLS

The Key Skills qualification requires that candidates demonstrate achievement in communication, application of number and information technology. Further guidance and details of the exact requirements may be obtained from separate WJEC support and guidance material.

The assessment units provide a range of possible opportunities both to develop Key Skills and generate evidence of attainment at level 3. The following table indicates the location within the assessment units of these opportunities. However, it does not preclude the presence of other opportunities within the assessment units which are dependent on individual teaching programmes and strategies.

Opportunities include: class discussions and presentations, the use of graphs and diagrams along with written descriptions to present and explain topics, data collection both through practical or laboratory work and through secondary sources such as the Internet and computerised information and retrieval systems.

What you must do	Content area reference within section 3
Communication (level 3)	
C3.1a Discussion	1.4 1.6 1.5 2.4 2.5 2.6 4.6 4.8 5.2 5.5
C3.1b Presentation	1.4 1.6 1.5 2.4 2.5 2.6 4.6 4.8 5.2 5.5
C3.2 Read and Synthesise	1.4 1.6 1.5 2.4 2.5 2.6 4.6 4.8 5.2 5.5
C3.3 Write	1.4 1.6 1.5 2.4 2.5 2.6 4.6 4.8 5.2 5.5

Application of number (level 3)				
N3.1 Plan and interpret				5.2
N3.2 Multi stage calculation	1.2			5.2
N3.3 Interpret results	1.2		4.5	5.2
N3.3 Present findings	1.2		4.5	5.2

Information technology (level 3)						
IT3.1 Plan and use sources	1.6	1.5	2.5	2.6	4.6 4.8	5.2 5.5
IT3.2 Develop and exchange	1.6	1.5	2.5	2.6	4.6 4.8	5.2 5.5
IT3.3 Present information	1.6	1.5	2.5	2.6	4.6 4.8	5.2 5.5

The wider Key skills of problem solving and working with others may be addressed, more particularly, through practical work, although the amassing of evidence for a group discussion, for instance on ethics, could also involve group working. Improving own learning and performance permeates all subject areas and assessment objectives, although it may be related to the acquiring of specific skills, as in competence in IT or laboratory procedures and equipment, or through the understanding of particularly complex areas of subject matter.

The following tables indicate the location of some possible opportunities for generating evidence for these wider key skills although individual teaching and learning strategies may affect these opportunities.

What you must do	Content area reference within section 3					
Problem solving (level 3)						
PS3.1 Explore problem and give 3 options for a solution	1.3	2.2	2.5	2.6	4.8	5.2
PS3.2 Plan and implement one option	1.3	2.2	2.5	2.6	4.8	5.2
PS3.3 Check solution	1.3	2.2	2.5	2.6	4.8	5.2

Working with others (level 3)												
WO3.1 Plan work together	1.2	1.3	1.4	1.6	2.3	2.5	2.6	4.5	4.6	4.8	5.2	5.5
WO3.2 Maintain co-operation	1.2	1.3	1.4	1.6	2.3	2.5	2.6	4.5	4.6	4.8	5.2	5.5
WO3.3 Review and propose improvements	1.2	1.3	1.4	1.6	2.3	2.5	2.6	4.5	4.6	4.8	5.2	5.5

Improving own learning and performance (level 3)							
LP3.1 Agree targets and plan work	1.1	1.6	2.5	2.6	4.5	4.6	4.8	5.4
LP3.2 Using plan	1.1	1.6	2.5	2.6	4.5	4.6	4.8	5.4
LP3.3 Review and propose improvements	1.1	1.6	2.5	2.6	4.5	4.6	4.8	5.4

5 *ASSESSMENT OBJECTIVES*

The assessment objectives (AO) 1, 2 and 3 are the same for AS and Advanced. AO1 and AO2 are assessed through theory papers, AO3 is assessed through practical work. AO4 applies only to the A2 part of the Advanced course.

In addition, the practical activities stipulated in section 3 (specification content) may be referred to on the theory papers.

AS modules will be assessed at AS level and A2 modules will be assessed at Advanced level, irrespective of when they are taken.

AO1 Knowledge with understanding

Candidates should be able to:

- recognise, recall and show understanding of specific biological facts, terminology, principles, concepts and practical techniques;
- draw on existing knowledge to show understanding of the ethical, social, economic, environmental and technological implications and applications of biology;
- select, organise and present relevant information clearly and logically, using appropriate vocabulary where appropriate.

AO2 Application of knowledge and understanding, analysis, synthesis and evaluation

Candidates should be able to:

- describe, explain and interpret phenomena and effects in terms of biological principles and concepts presenting arguments and ideas clearly and logically, using specialist vocabulary where appropriate;
- interpret and translate, from one form into another, data presented as continuous prose, or in tables, diagrams, drawings and graphs;
- apply biological principles and concepts in solving problems in unfamiliar situations including those which relate to the ethical, social, economic and technological implications and applications of biology;
- assess the validity of biological information, experiments, inferences and statements.

AO3 Experiment and Investigation

Candidates should be able to:

- devise and plan experimental and investigative activities, selecting appropriate techniques;
- demonstrate safe and skilful practical techniques;
- make observations and measurements with appropriate precision and record these methodically;
- interpret, explain, evaluate and communicate the results of their experimental and investigative activities clearly and logically using biological knowledge and understanding and using appropriate specialist vocabulary.

AO4 Synthesis of knowledge, understanding and skills

Candidates should be able to:

- bring together principles and concepts from different areas of biology and apply them in a particular context, expressing ideas clearly and logically and using appropriate specialist vocabulary.
- use biological skills in contexts which bring together different areas of the subject.

Assessment of the Quality of Written Communication

All four assessment objectives subsume the use of written communication. Use of appropriate language, punctuation and grammar is expected as the means by which ideas can be expressed and logical argument shown in answers to questions.

Markschemes therefore will, where appropriate, be constructed to allow for the presentation of coherent accounts, cogent argument and use of scientific terminology.

In addition, marks are allocated in the practical assessment for the production of clear scientific accounts.

6 *SCHEME OF ASSESSMENT*

Advanced Subsidiary

The AS examination consists of two theory (each 35% weighting) and one practical (30% weighting) assessment unit, at the level of demand expected half way through a full Advanced course of study.

The overall weightings of assessment objectives related to the assessment components are as follows:-

Assessment unit / Objective	BI1	BI2	BI3	Total
AO1 (Knowledge and understanding)	20%	20%	5%	45%
AO2 (Application)	15%	15%	5%	35%
AO3 (Practical)			20%	20%
AO4 (Synoptic)				
Total	35%	35%	30%	100%

Advanced Subsidiary Examination Papers

An approximate guide to the structure of the examination papers, BI1 and BI2 follows:-

Type of question	Marks per question	Number of questions per paper	
		BI1	BI2
Composite short answers	1	4 - 8	4 - 8
Short structured	5 - 8	5	5
Longer structured	10 - 15	1	1
Essay (1 out of 2)	10 - 12	1	1
Total marks		70	70
Time		1 hr 30 min	1 hr 30 min

Practical Assessment BI3

This assessment scheme is issued by the WJEC on an annual basis, during the spring term.

The assessment is based on the content of assessment units BI1 and BI2 and addresses AO3 as follows:-

Assessment	Mark allocation	Time
Planning	25	1 hour
Implementing	6	
Recording	4	1 hour
Analysis and evaluation	20	1 hour
Microscopy	15	45 minutes
Total	70	3 hrs 45 min

The investigations are to be conducted under open book, supervised conditions close to the time limits indicated above. The work may be carried out over one session or a series of sessions. The completed work is to be submitted to an external assessor for marking during the summer term by a date provided annually.

Implementing is assessed by teachers over a number of practical sessions throughout the year. A list of those practicals used and the marks awarded should be submitted with the practical assessment from each centre along with a signed proforma by which the teacher verifies the authenticity of each candidates unaided work.

See section 'Further guidance on the assessment of practical work' p 30 for further details.

Advanced GCE

The A2 examination consists of two theory (BI4, BI5) and one practical (BI6) assessment unit. The examination paper, BI5, is subdivided into sections A and B. The relative weightings of the A2 assessment objectives and the examination components are as follows:

Assessment unit / Objective	BI4	BI5	BI6	Total
AO1 (Knowledge and understanding)	15.5%	9.5%		25%
AO2 (Application)	14.5%	5.5%		20%
AO3 (Practical)			15%	15%
AO4 (Synoptic)		{ A10% B15%	15%	40%
Total	30%	40%	30%	100%

The intended approximate relationships between the relative weightings of the assessment objectives, and the examination components AS and A2 are shown in the grid below. The totals are approximate and are quoted only at the 5% level. Thus the absence of a figure in any box does not mean that the particular objective will not feature at all in the related examination component. The grid gives the likely emphasis on the skills in the different examination components. Whilst every effort will be made to keep to these totals it is not intended that the grid should give an exact specification for each operational paper.

Assessment unit / Objective	BI1	BI2	BI3	BI4	BI5	BI6	Total
AO1 (Knowledge and understanding)	10.0%	10.0%	2.5%	7.75%	4.75%		35.0%
AO2 (application)	7.5%	7.5%	2.5%	7.25%	2.75%		27.5%
AO3 (practical)			10.0%			7.5%	17.5%
AO4 (synoptic)					12.5%	7.5%	20.0%
Total	17.5%	17.5%	15.0%	15.0%	20.0%	15.0%	100%

Advanced GCE examination papers

Paper BI4 consists of the same sequence of questions as papers BI1 and BI2 but totalling 75 marks with the time allocation of 1 hr 40 mins.

Paper BI5 totals 90 marks with a 2hr time allocation. Section A, comprising 56 marks, assesses the subject content of the unit and consists of a similar sequence of questions as BI4 but with either a longer structured question or essay, at the examiners discretion. Some specific questions are synoptic but rooted in the subject content of this unit so contribute to the weighting of AO4.

Section B, comprising 34 marks, specifically addresses the synoptic assessment objective (AO4) largely by skills based questions such as comprehension and data response which require the bringing together of different parts of the course.

Practical Assessment Unit BI6

This practical assessment unit is assessed using a scheme provided by the WJEC on an annual basis during the latter part of the spring term. The parts of the assessment relating to planning, analysing and evaluating are considered synoptic in nature so contribute to AO4.

The content is based on the content of assessment units BI4 and BI5 addresses AO3 and AO4 as follows:-

Assessment	Mark allocation		Time
	AO3	AO4	
Planning	12	13	1 hour
Implementing	6		
Recording	4		1 hour
Analysis and evaluation		20	1 hour
Microscopy	13	2	1 hour
Total	35	35	4 hours

The investigations which include a statistical 't' test are to be conducted under open book, supervised conditions close to the time limits indicated above. The work may be carried out over one session or a series of sessions. The completed work is to be submitted to an external assessor for marking by during the summer term by a date provided annually.

Implementing is assessed by teachers over a number of practical sessions throughout the year. A list of those practicals used and the marks awarded should be submitted with the practical assessment from each centre along with a signed proforma by which the teacher verifies the authenticity of each candidates unaided work.

See section 'Further guidance on the assessment of practical work', p 30 for further details.

Subject content and synoptic assessment

Biology is inherently cyclical and therefore synoptic. However, certain content lends itself more easily to synoptic assessment as given in the guide below:

Module BI5 shows synoptic aspects with:

- Fundamental biochemistry (1.1 a, b)
- Basic cell structure and histology (1.2 a, b)
- Membrane structure and function (1.3 a, b)
- Enzyme inhibition (1.4 c)
- DNA, transcription and translation (1.6 a, c)
- Mitosis, meiosis and significance of reproduction (1.7 a, b)
- Importance of energy as ATP (4.1 a)
- Antibiotic use (4.6 b, 4.8 b)

Other synoptic links include:

- Ecological energy transfer (2.4 a) and energy harnessing (4.1 a)
- Recycling of nutrients (2.4 a) and basic chemical structure (1.1 a, 1.1 b, 1.6 a)
- Population growth (2.5 a) and microbiology (4.5 a)
- Pest control (2.6 b) and malaria (4.6 a)
- Alimentary canal (4.4 b) and enzyme function (1.4 a, b)
- Microbiology (4.5) and cell structure (1.2 a)
- Enzymes (1.4) and energy harnessing (4.1, 4.2, 4.3)
- Cell structure and energy harnessing (4.1 b, 4.2, 4.3)

Sequence and Availability of Assessment Units

The assessment scheme offers the opportunity for assessment either in stages throughout the course or for all assessments to be taken at the end of the course. There is no requirement to study the theory units in a particular order although progression in the order BI1, BI2, BI4, BI5, would provide a logical sequence. However, candidates should sit BI5 at the end of the course due to the presence of the synoptic component.

Availability of Assessment Units:

Year	BI1	BI2	BI3	BI4	BI5	BI6
Jan	✓	✓		✓		
June	✓	✓	✓	✓	✓	✓

Assessment Units BI1, BI2 and BI4 are available in January whilst BI1, BI2, BI4 and BI5 are available in June. BI3 and BI6 are both available annually.

Note: BI3 and BI6 will be available before June, for submission in May.

Resits

Each assessment unit may be retaken. The better result will count towards the final award. Candidates may, however, retake the whole qualification more than once.

Individual assessment unit results, prior to the certification of the qualification, have a shelf-life limited only by the shelf-life of the specification.

Awarding and Reporting Attainment

This specification complies with the grading, awarding and certification requirements of the GCE Code of Practice.

Both the AS and the full Advanced GCE qualification is graded on a scale A, B, C, D and E. Candidates who fail to reach the minimum standard for grade E are recorded as U (unclassified) and do not receive a qualification certificate.

Individual assessment unit results are certificated.

Further guidance on the assessment of practical work.

General Information

The assessment objectives for AS and A2 practical work are the same. The expectations and opportunities for practical work are rooted within the subject content in the relevant AS and A2 units. The demands are commensurate with the level expected part way through the advanced course for AS and having completed further studies for A2. Hence, the work will inherently involve slightly more complex and demanding activities for candidates at A2 compared with AS. Investigations at AS may therefore involve laboratory work with relatively simple planning, equipment and procedures such as: investigations into water potential and osmosis e.g. the effects of different salt concentrations on plasmolysis of plant cells; investigations involving enzymes which show progression from GCSE to AS such as the effect of rennet and hydrochloric acid on enzymes during digestion and the effect of pH on the rate of conversion of starch to maltose by amylase; simple ecological investigations such as the effects of soil water content on the plant diversity of sand dunes.

More complex planning and laboratory procedures for the Advanced part of the course include: chromatography, such as the separation of chloroplast pigments; extended serial dilution, for instance during microbiological investigations such as the bacteriostatic effects of antimicrobial agents e.g. disinfectants; respiration and photosynthesis, such as the effect of different wavelengths of light on the rate of photosynthesis; manipulation, such as the investigation of dehydrogenase activity in broad bean using tetrazolium compounds or gene segregation using *Sordaria* sp.

The use of ICT is encouraged where it may be employed as an appropriate tool for the task in hand. For instance, laboratory equipment may include sensors such as pH or oxygen probes linked to computerised data systems or computerised manipulation of data and statistical processing or computerised information sources and retrieval.

The basic assessment criteria are the same at AS and A2 levels however analysis and evaluation at AS level involves graphical presentation of data whilst at A2 level a statistical analysis is required. Microscope work at AS level involves calibration of the microscope and observation of the specimen at low power or plan level. However, at A2 level examination and drawing of a section at high power may be required, possibly with further related investigative activities.

Marking scheme.

Each practical will have a specific marking scheme broadly based on a generic scheme as follows. Some marks are based on performance levels where 2 marks are awarded for fully meeting the criteria and 1 mark for partially meeting the criteria. The exact requirements are determined by the individual markscheme for the paper, as amended at the examiners conference. It is based on what would be reasonably expected of an AS or Advanced candidate in relation to past performances of candidates at A level. Some marks are considered to be synoptic in nature since they require the application and bringing together of knowledge and/or skills acquired from different parts of the course. The synoptic A2 marks contribute towards the AO4 weighting. The mark allocation is as follows:

AS and A2 assessment

Planning			**Synoptic Marks**
1.	Aim of the investigation - a quantitative statement	[2]	2
2.	Biological theory/model clearly explained	[2]	2
3.	Selection of apparatus and listed	[2]	2
4.	Drawing of the apparatus set up	[2]	
5.	Variables identified:		
(a)	Independent and range to be used	[1]	1

	(b)	Dependent	[1]	1
	(c)	Controlled variables	[2]	2
6.		Suitable experimental control	[1]	1
7.		Risk assessment - the nature of the risk and how it will be minimised	[2]	2
8.		Logical sequence of the steps involved:		
	(a)	The steps must be repeatable and the appropriate units of measurement used	[5]	
	(b)	Precision of measurement	[1]	
	(c)	Suitable repeats	[2]	2
	(d)	Clear scientific account	[2]	

Total 25 marks

Observation and Recording of Results

1.		Suitable table with suitable title and correct headings (it is good practice to place the independent variable first).	[2]
2.		Recording accuracy - precision commensurate with instruments used (e.g. ± 1mm) and sufficient repeats (3 - 5) plus means recorded.	[2]

Total 4 marks

Implementing

This skill is to be teacher assessed over a number of practical sessions.
The skills must be commensurate with A/AS level and a list of the assessed practicals will be required by the board.

1.		Carrying out the practical in a careful and organised way	[2]
2.		Manipulative skills.	
	(a)	Setting up the apparatus correctly	[2]
	(b)	Precise manipulation of key instruments	[2]

Total 6 marks

AS assessment

Analysis and Evaluation

1.		The processing of data in a suitable format i.e. graphs as appropriate.	
	(a)	Correct axes and units with the independent variable on the X axis	[2]
	(b)	Accurate plotting of plots	[2]
	(c)	The drawing of a line or curve of best fit (if sufficient data are available) or, as appropriate, the joining of plots with no extrapolation	[2]
	(d)	Suitable scales on the graph	[2]
2.		Error bars drawn on the graph/comment on the reliability of the results	[2]
3.		Describe the limitations of the apparatus, materials and the method and all possible sources of error in the investigation	[2]
4.		Draw suitable conclusions using the data	[2]
5.		Explanation of the conclusions using biological knowledge. This is to be relevant, concise and accurate and comment on the validity of the investigation	[4]
6.		Improvement or extension to the investigation	[2]

Total 20 marks

AS assessment			**Synoptic Marks**
Observation - Microscopy			
1.	Calibration of the microscope for the appropriate objective lens	[1]	
2.	Correct statement of eyepiece divisions equating with the correct micrometer units	[1]	
3.	Actual calculation of 1 eyepiece division in the appropriate units	[1]	
Quality of the drawing			
1.	A large drawing of the correct distribution of all tissues	[2]	
2.	Clean, single, sharp and complete lines with no shading	[2]	
3.	Drawing the correct proportions of all tissues	[2]	
4.	The correct identification by unambiguous labelling	[2]	
5.	A line drawn on the drawing to show its maximum length/width. The correct measurements in mm, annotated on the line (+/– 1mm error allowed)	[2]	
6.	Using the values above show how the magnification of the drawing was calculated	[2]	
		Total 15 marks	
A2 assessment			
Analysis and Evaluation			
Numerical processing of results using statistical methods. Correct use of t test.			
1.	Null hypothesis stated	[1]	1
2.	Calculate deviations from the mean	[2]	
3.	Correct substitution into the formula	[2]	
4.	Correct statement of degrees of freedom	[1]	
5.	Correct method to generate a value	[2]	
6.	Use the value generated to explain the validity of the results using confidence levels	[2]	2
7.	Conclusions, using biological principles	[6]	6
8.	Limitations of the experiment and all sources of error	[2]	2
9.	Improvements or extensions to the investigation	[2]	2
		Total 20 marks	
A2 assessment			
Observation - Microscopy			
1.	A large drawing of the correct distribution of all tissues	[2]	2
2.	Clean, single, sharp and complete lines with no shading	[2]	
3.	Drawing the correct proportions of all tissues	[2]	
4.	The correct identification	[2]	2
5.	The correct measurements	[1]	
6.	Further explanation or observations (according to context)	[6]	3
		Total 15 marks	**35**

Assessment

The practical assessment overall should be viewed in the same way as a theory examination with regard to security and malpractice.

The practical work, supplied by WJEC on an annual basis at both AS level and A2 level, may each be carried out in a series of one hour practical sessions or on 1 day or blocks at the centre's discretion. The assessment scheme may require the planning and carrying out of one investigation or the carrying out of a different investigation, in order to generate results for analysis. If planning and implementing involve the same investigation, planning may be carried out in a 1 hour session and candidates then carry out the plan in another session. In between sessions the plans should be retained by the teacher. Small adjustments to the plan are permissible as points may become apparent during the carrying out session but any amendments must be annotated as being later adjustments. If a different investigation is used for carrying out then the planning work should be retained by the teacher with no further amendment.

It is recommended that any experimental work supplied by WJEC is pretested in the centre beforehand.

Implementing

This refers to the assessment of the practical performance of a candidate by their ability to work in a safe, ordered manner, showing good laboratory practice and using common biological equipment in a competent, precise and skilful manner.

The skills are teacher assessed either during the practical scheme provided by WJEC annually or during other practical sessions throughout the year. There is no set time for this assessment but it is anticipated that no practical exercise would take more than one hour.

Three skills are assessed: carrying out the work; setting up apparatus correctly; precise manipulation of key instruments. Only one mark is required for each skill although each may be assessed on several occasions and not all need to be assessed at the same time. Assessments should be made during practical sessions where candidates are able to demonstrate their skills adequately and at a level commensurate with the level of AS or A2 as appropriate.

The marks are allocated on a performance level basis covering marks 0, 1 and 2. The precise requirements for the allocation of 2 marks is dependant upon the nature of the activity being carried out. For instance, manipulation, in microscopy for a candidate who carefully prepared a wet mount with few air bubbles and no spillage around the coverslip.

The three skills should be assessed according to the performance level criteria as follows:

	Performance level marks		
Skill	**0**	**1**	**2**
Carrying out the work.	Little care taken or organisation with little attention to safety.	Limited care taken and organisation, with some attention to safety.	Careful and well organised, safety conscious.
Setting up apparatus correctly.	Little skill shown setting up/using apparatus	Apparatus set up/used with limited skill.	Apparatus set up/used well and correctly
Precise manipulation of key instruments	Instruments manipulated with little precision or skill.	Instruments manipulated with limited precision and skill	Instruments manipulated with great precision and skill.

A list of the practicals during which the assessment was made for each candidate and a list of the marks obtained must be supplied to WJEC using proforma BIAS or BIA for AS and A2 as appropriate and on C forms. Copies of BIAS and BIA may be found in appendix 3.

Lines of Best fit

If there is a continuous relationship between the two variables plotted on a graph, a line of best fit should be drawn joining, or approximating to, the points. Mathematical relationships may be deduced from this line.

In a great deal of biological data there is no such continuous relationship. In this case a series of straight lines should be used to join successive points. The values between the points cannot be shown on the graph and cannot be deduced from the readings. A smooth curve should therefore only be used if there is good reason to think that the intermediate values would fall on that curve. Joining points by straight lines indicates that the points in between recorded points are unknown and that, in addition, how they vary between recorded points is also unknown.

In other disciplines a 'line of best fit' is regarded as the norm and the possibility of straight line joining of points is not considered. Therefore, an awareness of the particular requirements for presenting biological data is required and the need for appropriate explanation to enable an understanding of why this difference occurs.

7 GRADE DESCRIPTIONS

The following grade descriptions indicate the level of attainment characteristic of the given advanced grade GCE. They give a general indication of the required learning outcomes at each specified grade. The descriptions should be interpreted in relation to the content outlined in the specification; they are not designed to define that content. The grade awarded will depend in practice upon the extent to which the candidate has met he assessment objectives overall. Shortcomings in some aspects of the examination may be balanced by better performances in others.

Grade A

Candidates recall and consistently use biological knowledge, facts, principles and concepts from the whole specification with few significant omissions and show good understanding of the principles and concepts they use. They select biological knowledge relevant to most situations and present their ideas clearly and logically, making use of appropriate biological terminology, particularly when referring to specific technical terms and in expressing more general concepts and ideas.

Candidates carry out accurately a range of calculations in a logical manner with little guidance and, where appropriate, support their solutions by logical explanation. They demonstrate good understanding of principles and apply them in familiar and new contexts. They show insight into problems and suggest a number of possible solutions using techniques, arguments or knowledge and understanding from more than one area of the specification and other areas of their experience. Most responses are correct, relevant and logical. In particular, longer questions are answered to an appropriate depth, communicating ideas effectively with coherent and detailed explanations.

In experimental activities, candidates independently formulate a clear and accurate plan. They use a range of manipulative techniques safely and skilfully, making and recording observations with appropriate precision. They interpret and describe the trends and patterns shown by data presented in tabular or graphical form, indicating, where appropriate, anomalies and inconsistencies. They provide coherent, logical and comprehensive explanations using appropriate biological knowledge and terminology. They comment critically on data, evaluate it and use it to support or reject various hypotheses. They present clearly and concisely both sides of an argument by weighing up the evidence.

Grade C

Candidates recall and show a sound use of biological knowledge, facts, principles and concepts from many parts of the specification and show understanding of some fundamental principles and concepts. They frequently select biological knowledge relevant to a particular situation or context and present their ideas clearly and logically, making use of appropriate biological terminology.

Candidates carry out a range of calculations, making progress with minimal guidance. They show knowledge of fundamental principles and are often able to apply these in new contexts. They bring together information from more than one area of the specification. Many responses are correct, relevant and logical.

In experimental activities, candidates formulate a plan which may need some modification. They use a range of techniques safely, making and recording observations and measurements which are adequate for the task. They interpret and explain experimental results relating these to biological knowledge and understanding and, with help, evaluate their results. They comment on data and use selected data to support a particular hypothesis. They make choices in statistical sampling.

Grade E

Candidates recall and use biological knowledge, facts, principles and concepts from some parts of the specification and demonstrate some understanding of fundamental principles and concepts beyond that expected of sound GCSE candidates.

Candidates select discrete items of knowledge in response to structured questions and use basic biological terminology. This may be displayed consistently across the questions set or may vary between quite good and poor on different questions.

Candidates select appropriate facts and principles to solve problems concerning familiar material. Where problems are concerned with unfamiliar material, answers relate to the appropriate subject area even if difficulties are experienced in applying the facts and principles involved.

With some guidance, candidates carry out accurately straightforward calculations involving the rules of number, such as calculations of percentages, making clear the steps in the calculation. They apply knowledge and biological principles contained within the specification material presented in a familiar or closely related context.

They make connections between some ideas encountered in different parts of the specification. Their answers show some logic and coherence although they may include irrelevant material. They use correctly a limited range of biological terminology.

In experimental activities, candidates formulate some elements of a practical approach when provided with guidance. They carry out frequently encountered practical procedures in a reasonably skilful manner, recognising the risks in familiar procedures and obtaining some appropriate results. They interpret broad trends shown by data presented in tabular or graphical form. They select appropriate facts and principles to produce limited but relevant explanations and make superficial conclusions from data. They may need assistance to relate these to biological knowledge and understanding.

Appendix 1

Mathematical Requirements

In order to be able to develop the knowledge, understanding and skills in biology specifications, students need to have been taught and to have acquired competence in the areas of mathematics set out below. Material given in bold type is for Advanced GCE only.

Arithmetic and computation

Students should be able to:

(a) recognise and use expressions in decimal and standard form;
(b) use ratios, fractions and percentages;
(c) make estimates of the results of calculations (without using a calculator);
(d) use calculations to find and use x n, 1/x and √x.

Handling data

Students should be able to:

(a) use an appropriate number of significant figures;
(b) find arithmetic means;
(c) construct and interpret frequency tables and diagrams, bar charts and histograms;
(d) **have sufficient understanding of probability to understand how genetic ratios arise;**
(e) **understand the principles of sampling as applied to biological data;**
(f) **understand the importance of chance when interpreting data;**
(g) **understand the terms mean, median and mode;**
(h) **use a scatter diagram to identify a correlation between two variables;**
(i) **use a simple statistical test.**

Algebra

Students should be able to:

(a) change the subject of an equation;
(b) substitute numerical values into algebraic equations using appropriate units for physical quantities.

Graphs

Students should be able to:

(a) translate information between graphical, numerical and algebraic forms;
(b) plot two variables from experimental or other data;
(c) calculate rate of change from a graph showing a linear relationship.

Appendix 2

Terms used in Examination Questions

Examination questions are worded extremely carefully so that they are concise and unambiguous. Despite this, candidates tend to penalise themselves unnecessarily when they mis-read questions, either because they read them too quickly or too superficially. It is essential that candidates appreciate the precise meaning of each word in the question if they are to be successful in generating concise, relevant and unambiguous responses. The mark value which follows each part of each question provides a useful guide as to the amount of information required in the answer. A list of words frequently used in examination questions, together with their approximate meanings follows:

Annotate	Give notes of explanation, For example, each label of a large labelled annotated diagram would include a short description of its function and/or structure, as appropriate.
Brief	A short statement of only the main points.
Calculate	Work out, showing all stages in the derivation of the answer.
Compare	Write about the similarities **and differences** between two or more, for example, structures or processes.
Criticise	State the faults/shortcomings of, for example, an experiment.
Define	State the meaning of, for example, a term without actually using the term itself.
Describe	A request for factual detail about, for example, a structure or process expressed logically and concisely.
Diagrams	These should always be large, drawn in the correct proportion, **fully labelled**, have a title and, when appropriate, be referred to in the text of a response. Label lines should be drawn with a ruler so that they do not cross other label lines. They should touch the appropriate structure. Colour and shading should normally be avoided.
Discuss	A critical account of the various viewpoints and arguments in the topic set, drawing attention to their relative importance and significance.
Distinguish between	State the differences between, for example, two or more terms often for the purpose of identification.
Explain	Describe and give reasons for.

Graphs	These should: a) be plotted in **pencil** so that they can be corrected neatly. b) make maximum use of the paper. c) have fully labelled axes, curves and, where appropriate, a title. d) have all points marked clearly on each curve using, for example, an x but never just a dot. e) have points of a particular curve joined by a series of straight lines drawn with a ruler or with a smooth curve, but never with a sketchy line. f) take note of any particular instructions given in the question. When a graph is being interpreted it is essential to relate any changes/trends to its biological context, using data as support where possible.
Illustrate	Include diagrams/drawings/figures as much as possible.
List	A sequence of numbered points one below the other.
Name	Write the full name.
Outline	Give the main points.
State	A concise answer giving no reasons.
Suggest	Give hypotheses/ideas/thoughts on a subject not necessarily 'known' to the candidate.
What is meant by	A definition is usually required. The amount of information to be included is dictated by the mark value.
Using the data	Numerical answer required.

Appendix 3

WELSH JOINT EDUCATION COMMITTEE **CYD-BWYLLGOR ADDYSG CYMRU**
General Certificate of Education **Tystysgrif Addysg Gyffredinol**

BIAS

ADVANCED SUBSIDIARY BIOLOGY
BIOLEG UWCH GYFRANNOL
Assessment of Practical Work
Asesiad o Waith Ymarferol

Name of Centre *Enw'r Ganolfan*	**Centre Number** *Rhif y Ganolfan*	**Year** *Blwyddyn*

Marks awarded for implementing practical work: carrying out (c), setting up apparatus (s), manipulating instruments (m). The three skills may be assessed using one or more than one practical exercise. The best single mark for each skill counts towards the total.

Exercise used for assessment and date											**Total Mark (6)**
Candidate's Number	**Name**	**C**	**S**	**M**	**C**	**S**	**M**	**C**	**S**	**M**	

N.B. **This copy should be sent to the examiner with the completed practical scripts. The marks should also be entered on 'C' forms and sent to the WJEC.**

D.S. ***Dylid anfon y copi hwn at yr arholwr gyda'r sgriptiau ymarferol wedi'u llenwi. Dylid hefyd nodi'r marciau ar y ffurfleni 'C' a'u hanfon i CBAC.***

DECLARATION I certify that the work of the above candidates has been carried out under the conditions required by the WJEC and that, to the best of my knowledge and belief, it has been produced by each candidate's own efforts.

DATGANIAD ***Tystiaf bod gwaith yr ymgeiswyr uchod wedi ei wneud o dan amodau a bennir gan CBAC a'i fod, hyd y gwn ac y credaf, yn gynnyrch ymdrechion yr ymgeisydd ei hun.***

Subject Teacher/*Athro'r Pwnc*	**Head Teacher/*Prifathro***	**Date/*Dyddiad***

WELSH JOINT EDUCATION COMMITTEE **CYD-BWYLLGOR ADDYSG CYMRU**
General Certificate of Education **Tystysgrif Addysg Gyffredinol**

BIA

ADVANCED GCE BIOLOGY
BIOLEG TAG UWCH
Assessment of Practical Work
Asesiad o Waith Ymarferol

Name of Centre *Enw'r Ganolfan*	**Centre Number** *Rhif y Ganolfan*	**Year** *Blwyddyn*

Marks awarded for implementing practical work: carrying out (c), setting up apparatus (s), manipulating instruments (m). The three skills may be assessed using one or more than one practical exercise. The best single mark for each skill counts towards the total.

Exercise used for assessment and date											**Total Mark (6)**
Candidate's Number	**Name**	**C**	**S**	**M**	**C**	**S**	**M**	**C**	**S**	**M**	

N.B. **This copy should be sent to the examiner with the completed practical scripts. The marks should also be entered on 'C' forms and sent to the WJEC.**

D.S. ***Dylid anfon y copi hwn at yr arholwr gyda'r sgriptiau ymarferol wedi'u llenwi. Dylid hefyd nodi'r marciau ar y ffurfleni 'C' a'u hanfon i CBAC.***

DECLARATION I certify that the work of the above candidates has been carried out under the conditions required by the WJEC and that, to the best of my knowledge and belief, it has been produced by each candidate's own efforts.

DATGANIAD ***Tystiaf bod gwaith yr ymgeiswyr uchod wedi ei wneud o dan amodau a bennir gan CBAC a'i fod, hyd y gwn ac y credaf, yn gynnyrch ymdrechion yr ymgeisydd ei hun.***

Subject Teacher/*Athro'r Pwnc*	**Head Teacher/*Prifathro***	**Date/*Dyddiad***

Appendix 4. THE EXEMPLIFICATION OF KEY SKILLS

The following tables give some examples of Biology contexts in which naturally occurring key skills evidence could be accumulated.

Note: If producing certain types of evidence creates difficulties due to disability or other factors, the candidate may be able to use other ways to show achievement. The candidate should ask the tutor or supervisor for further information.

COMMUNICATION: LEVEL 1

C1.1 TAKE PART IN A DISCUSSION			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
take part in a **one-to-one** discussion and a **group** discussion about different, straightforward subjects.	• provide information that is relevant to the subject and purpose of the discussion • speak clearly in a way that suits the situation • listen and respond appropriately to what others say.	Records from an assessor who observed each discussion and noted how the student met the requirements of the Unit, or an audio/video tape of the discussions.	One-to-one and group discussion on a scientific issue e.g. conservation.

C1.2 INFORMATION GATHERING			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
read and obtain information from **two** different types of documents about straightforward subjects, including at least **one** image.	• read relevant material • identify accurately the main points and ideas in material • use the information to suit the purpose.	A record of what the student reads and why, including a note or copy of the image. Notes, highlighted text or answers to questions about the material read. Records of how the student used the information. *Eg* in discussions for C1.1 or writing for C1.3.	Answers to questions requiring information from two sources e.g. a text book, a worksheet or the Internet on a topic such as conservation.

C1.3 WRITING			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
write **two** different types of documents about straightforward subjects. Include at least **one** image in one of the documents.	• present relevant information in a form that suits the purpose • ensure text is legible • make sure that spelling, punctuation and grammar are accurate so the meaning is clear.	The two different documents might include a letter, a short report or essay, with an image such as a chart or sketch.	A report or an essay including diagrams on a selected topic e.g. cell structure.

COMMUNICATION: LEVEL 2

C2.1a CONTRIBUTE TO A DISCUSSION			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
contribute to a discussion about a straightforward subject.	• make clear and relevant contributions in a way that suits the purpose and situation • listen and respond appropriately to what others say • help to move the discussion forward.	A record from an assessor who observed the discussion and noted how the student met the requirements of the Unit, or an audio/video tape of the discussion.	Classroom discussion on a scientific issue e.g. conservation.

C2.1b GIVE A SHORT TALK			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
give a short talk about a straightforward subject using an image.	• speak clearly in a way that suits the subject, purpose and situation • keep to the subject and structure the talk to help listeners follow what the student says • use an image to illustrate clearly the main points.	A record from an assessor who observed the talk, or an audio/video tape of the talk. Notes from preparing and giving the talk. A copy of the image used.	Use an O.H.P. to give a brief explanation of a scientific topic to others e.g. differences between plant and animal cells.

C2.2 INFORMATION GATHERING			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
read and summarise information from **two** extended documents about a straightforward subject. One of the documents should include **at least one** image.	• select and read relevant material • identify accurately the lines of reasoning and main points from text and images • summarise the information to suit the purpose.	A record of what is read and why, including a note or copy of the image. Notes, highlighted text or answers to questions about the material read. Evidence of summarising information could include the student's notes for the talk, or one of the documents written.	Notes or annotations of different sources relating to a scientific topic e.g. fossil record as evidence for evolution.

C2.3 WRITING			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
write **two** different types of documents about straightforward subjects. One piece of writing should be an extended document and include **at least one** image.	• present relevant information in an appropriate form • use a structure and style of writing to suit the purpose • ensure the text is legible and that spelling, punctuation and grammar are accurate, so the meaning is clear.	The two different documents might include a report or an essay, with an image such as a chart, graph or diagram, a business letter or notes.	Write an account or report which includes a diagram, chart or graph on a scientific topic e.g. food chains.

COMMUNICATION: LEVEL 3

C3.1a TAKE PART IN A DISCUSSION			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
contribute to a group discussion about a complex subject.	• make clear and relevant contributions • listen and respond appropriately • create opportunities for others to take part.	A record from someone who has observed discussion or has made video/ audio tape of discussion.	Discussion of controversial issues such as genetic engineering.

C3.1b MAKE A PRESENTATION			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
make a presentation about a complex subject, using at least **one** image to show complex points.	• speak clearly and use suitable style • structure ideas and information • use a range of techniques.	A record from someone who has observed discussion or has made video/ audio tape of discussion or preparatory notes with images.	Present information about a controversial issue such as gene therapy.

C3.2 INFORMATION GATHERING			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
select and synthesise information from **two** extended documents that deal with a complex subject **One** of these documents should include at least one image.	• select and read material that contains information needed • identify accurately, and compare, the lines of reasoning and main points from texts and images • synthesise the key information in a suitable form.	A record of what was read and why, including a note of the image. Notes, highlighted text or answers to questions about material read. Evidence of synthesising information from notes of a presentation or a written document.	Collect information regarding the risks, advantages and disadvantages of genetically modified crops.

C3.3 WRITING			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
write **two** different types of document**s** about complex subjects. **One** piece of writing should be an extended document and include at least **one** image.	• select and use appropriate style of writing • organise relevant information clearly and coherently, using specialist vocabulary • ensure text is legible, spelling, punctuation and grammar are accurate, and that meaning is clear.	The two different documents might include an extended essay or report, with an image such as a chart, graph or diagram and a letter or memo.	Prepare documents regarding various aspects of genetic engineering including an explanation of gene transfer.

APPLICATION OF NUMBER: LEVEL 1

N1.1 INTERPRET STRAIGHTFORWARD INFORMATION			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
Interpret straightforward information from **two** different sources. At least **one** source should be a table, chart, diagram or line graph.	• Obtain the information needed to meet the purpose of the task; and • Identify suitable calculations to get the results needed.	Description of the tasks and purposes. Copies of source material. A statement from an assessor who checked the accuracy of the student's measurements or observations (if this was done). Records of the information obtained and the types of calculations identified to get the results needed.	Analysis of results obtained from practical work.

N1.2 CARRY OUT STRAIGHTFORWARD CALCULATIONS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
Carry out straightforward calculations to do with: a. amounts and sizes; b. scales and proportion; c. handling statistics.	• Carry out calculations to the levels of accuracy the student has been given; and • Check the results make sense.	Records of the calculations (for a, b and c) and how the student checked them.	Calculations regarding the scale of diagrams of specimens.

N1.3 INTERPRET THE RESULTS OF CALCULATIONS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
Interpret the results of the calculations and present her/his findings. The student must use **one** chart and **one** diagram.	• Choose suitable ways to present findings; • Present findings clearly; and • Describe how the results of the calculations meet the purpose of the task.	Descriptions of the findings and how the results of the calculations met the purpose of the tasks. At least **one** chart and **one** diagram presenting the findings.	Practical work such as interpreting the scale/magnification of light microscopy.

APPLICATION OF NUMBER: LEVEL 2

Candidates must carry through at least **one** substantial activity that includes a number of straightforward **related tasks** for N2.1, N2.2 and N2.3.

N2.1 INTERPRET INFORMATION			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
Interpret information from **two** different sources, including material containing a graph.	• Choose how to obtain the information needed to meet the purpose of the activity; • Obtain the relevant information; and • Select appropriate methods to get the results needed.	A description of the substantial activity. Copies of source material, including the graph, and/or a statement from someone who has checked the accuracy of the student's measurements and observations. Records of the information obtained and the methods selected for getting the results needed.	Analysis of results obtained from practical work.

N2.2 CARRY OUT CALCULATIONS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
Carry out calculations to do with: a. amounts and sizes; b. scales and proportion; c. handling statistics; d. using formulae.	• Carry out calculations, clearly showing methods and levels of accuracy; and • Check methods to identify and correct any errors, and making sure the results make sense.	Records of calculations (for a, b, c and d), showing methods used and levels of accuracy. Notes on how the student checked methods and results.	Microscope calibrations and use of error bars on graphs.

N2.3 INTERPRETING THE RESULTS OF CALCULATIONS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
Interpret the results of calculations and present findings. The student must use at least **one** graph, **one** chart and **one** diagram.	• Select effective ways of presenting findings; • Present findings clearly, describing methods; and • Explain how the results of the calculations meet the purpose of the study.	Descriptions of findings and methods. Notes on how the results from the calculations met the purpose of the activity. At least **one** graph, **one** chart and **one** diagram presenting the findings.	Scale diagrams of specimens and comparing the scale/magnification of light and electron microscopy.

APPLICATION OF NUMBER: LEVEL 3

Candidates must plan and carry through at least **one** substantial and complex activity that includes a number of **related** tasks for N3.1, N3.2 and N3.3.

N3.1 INTERPRET INFORMATION			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
Plan and interpret information from **two** different sources, including a large data set.	• Plan how to obtain the information required to meet the purpose of the activity; • Obtain the relevant information; and • Choose appropriate methods for obtaining the results needed and justify the choice.	A description of the activity and tasks. Copies of source material, including a note of the large data set. A statement from someone who has checked the accuracy of any measurements or observations. Records and a justification of methods selected.	Analysis of results obtained from practical work.

N3.2 CARRY OUT MULTI-STAGE CALCULATIONS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
Carry out multi-stage calculations to do with: a. amounts and sizes; b. scales and proportion; c. handling statistics; d. rearranging and using formulae.	• Carry out calculations to appropriate levels of accuracy, clearly showing methods; and • Check methods and results to help ensure errors are found and corrected.	Records of calculations (for a, b, c and d). Showing methods used and levels of accuracy. Notes on the large data set and how the methods and results were checked.	Application of statistics e.g. t test and error bars to experimental results.

N3.3 INTERPRETING THE RESULTS OF CALCULATIONS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
Interpret the results of calculations, present findings and justify methods. The student must use at least **one** graph, **one** chart and **one** diagram.	• Select appropriate methods of presentation and justify choice; • Present findings effectively; and • Explain how the results of the calculations relate to the purpose of the activity.	Report justifying methods and explanation of how results relate to the activity. At least **one** graph, **one** chart and **one** diagram.	Interpretation of experimental results using the t test.

INFORMATION TECHNOLOGY: LEVEL 1

IT 1.1 FIND, STORE AND DEVELOP INFORMATION			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
find, explore and develop information for **two** different purposes.	• find and select relevant information • enter and bring in information, using formats that help development • explore and develop information to meet the student's purpose.	Print-outs and copies of the information the student selects to use. A record from an assessor who observed the student using IT when exploring and developing information or working drafts with notes of how the student met the requirements of the Unit.	Search for scientific data, written/visual sources on a website or CD ROM. The information found would be used to inform a discussion, develop an assignment, contribute to practical work etc. e.g. endangered species.

IT 1.2 PRESENT INFORMATION			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
present information for **two** different purposes. The student's work must include **at least one** example of text, **one** example of images, and **one** example of numbers.	• use appropriate layouts for presenting information in a consistent way • develop the presentation so it is accurate, clear and meets the purpose • save information so it can be found easily.	Working drafts showing how the student developed the presentation or records from an assessor who saw the student's screen displays. Print-outs or prints of a static or dynamic screen display of the students final work, including examples of text, images and numbers. Records of how the student saved information.	The information gained from a search of sources e.g. the Internet could be presented using various formats e.g. a leaflet or 'publicity' poster on endangered species.

INFORMATION TECHNOLOGY: LEVEL 2

IT 2.1 SEARCH FOR AND SELECT INFORMATION			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
search for and select information for **two** different purposes.	• identify the information needed and suitable sources • carry out effective searches • select information that is relevant to the student's purpose.	Print-outs of the relevant information with notes of sources and how the student made searches, or a record from an assessor who observed the student using IT when searching for information.	Search for scientific data, written/visual sources on a website or CD ROM. The information found would be used to inform a discussion, develop an assignment, contribute to practical work etc. e.g. endangered species.

IT 2.2 EXPLORE AND DEVELOP INFORMATION			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
explore and develop information, and derive new information, for **two** different purposes.	• enter and bring together information using formats that help developments • explore information as needed for the purpose • develop information and derive new information as appropriate.	Print-outs, or a record from an assessor who observed the student using IT, with notes to show how the student explored and developed information and derived new information.	The information gained from a search of sources e.g. the Internet could be developed and enhanced using various formats e.g. a leaflet or 'publicity' poster on endangered species.

IT 2.3 PRESENT COMBINED INFORMATION			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
present combined information for **two** different purposes. The student's work must include at least **one** example of text, **one** example of images and **one** example of numbers.	• select and use appropriate layouts for presenting combined information in a consistent way • develop the presentation to suit the purpose and the types of information • ensure the work is accurate, clear and saved appropriately.	Working drafts, or a record from an assessor who observed the screen displays, with notes to show how the student developed content and presentation. Print-outs, or prints of static or dynamic screen displays, of the final work, including examples of text, images and numbers. Records of how the information was saved.	Information obtained through the use of IT and developed using a variety of software packages (e.g. word processing, graphics, DTP) could be presented in an extended essay or practical work.

INFORMATION TECHNOLOGY: LEVEL 3

Candidates must plan and carry through at least **one** substantial activity that includes a number of related tasks for IT3.1, IT3.2 and IT3.3.

IT 3.1 SEARCH AND SELECT INFORMATION			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
compare and use different sources to search for, and select, information required for **two** different purposes.	• plan how to obtain and use information • choose appropriate techniques for searches • make selections based on judgements.	Print-outs with notes of sources and how searches made and selected information A record from someone who observed use of IT to search for and explore information.	Obtaining information from various organisations regarding environmental issues.

IT 3.2 DEVELOP INFORMATION			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
explore, develop and exchange information and derive new information to meet **two** different purposes.	• bring together information in consistent form • create and use appropriate structures • use methods for exchanging information.	Print-outs or record of someone who observed use of IT showing how information has been exchanged, explored and developed. Notes of automated routines	Assemble information on populations and predicted population changes.

IT 3.3 PRESENT INFORMATION			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
present information from different sources for **two** different purposes and audiences. **One** example of text, **one** of images and **one** of numbers.	• develop structures and content • present information effectively • ensure work is accurate.	Working drafts or a record from an assessor who observed screen displays, showing how developed for presentation. Print-outs or a static or dynamic screen display of final work, including text, images and numbers.	Present the information obtained on populations and/or environmental issues in an appropriate format.

WIDER KEY SKILLS

PROBLEM SOLVING: LEVEL 1

Candidates must provide at least **two** examples of meeting the standard for PS1.1, PS1.2 and PS1.3.

PS 1.1 CONFIRM PROBLEMS AND IDENTIFY OPTIONS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
confirm understanding of the given problem and identify at least **two** options for solving it, with help from an appropriate person.	• check that the problem is understood, and how to succeed in solving it • identify different ways of tackling the problem • decide, with help, which options are most likely to be successful.	Descriptions of the two problems and how they have been solved. Descriptions of ways for solving the two problems and the options most likely to be successful. Records of help given.	Students choose a Scientific topic for an extended essay or coursework study and make notes or essay plans considering two was of approaching it. This could involve group/class discussion of aspects/ approaches and of possible sources of information (e.g. alternative ways of finding information). The topic might itself contain problems on which there are different Scientific perspectives.

PS 1.2 PLAN AND TRY OUT OPTIONS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
plan and try out at least **one** option for solving the problem, using given evidence and support.	• confirm with an appropriate person the option to be tried for solving the problem • plan how to carry out this option • follow through the plan, making use of advice and support given by others.	Statements on how the student confirmed the options to be tried out. A plan for trying out each option. Records of what was done in following the plan, with notes on the advice and support given.	Present notes or essay plan which is discussed with the teacher and then executed through the writing of a piece of coursework. Review the piece of work produced with a view to modifying, expanding or restructuring it.

PS 1.3 CHECK AND DESCRIBE RESULTS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
check if the problem has been solved and describe the results, including ways to improve the approach.	• check whether the problem has been solved successfully • describe clearly the results of tackling the problem • identify ways of improving the approach to problem solving.	Records of the methods given and they were used. Descriptions of the results of tackling the problems and ways to improve the approach to problem solving.	Discuss with the teacher the piece of work to ensure that the problem or issue has been addressed appropriately. Describe the results in a log of procedural research.

PROBLEM SOLVING: LEVEL 2

Candidates must provide at least **two** examples of meeting the standard for PS2.1, PS2.2 and PS2.3.

PS 2.1 IDENTIFY PROBLEMS AND OPTIONS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
identify the problem and come up with **two** options for solving it.	• identify the problem, accurately describing its main features and how to show success in solving it • come up with different ways of tackling the problem • decide which options have a realistic chance of success, using help from others when appropriate.	Descriptions of the two problems and how the student is going to show they have been solved successfully. Descriptions of ways for solving the two problems. Records of how the student decided which options were most realistic, including the help obtained.	Students identify a Scientific topic for an extended essay or coursework study and make notes or essay plans considering two ways of approaching it. This could involve group/class discussion of aspects/ approaches and of possible sources of information (e.g. alternative ways of finding information). The topic might itself contain a problem on which there are different Scientific perspectives.

PS 2.2 PLAN AND TRY OUT OPTIONS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
plan and try out at least **one** option for solving the problem, obtaining support and making changes to the plan when necessary.	• confirm with an appropriate person the option to be tried for solving the problem, and plan how to carry it out • follow the plan, organising the relevant tasks and making changes to the plan when necessary • obtain and effectively use support needed.	Statements on how the options were confirmed and tried out. A plan for trying out each option. Records of what was done, including any changes made to the plan. Notes of the support obtained and how this was used effectively.	Present notes or essay plan which is discussed with the teacher and then executed through the writing of a piece of coursework. Review the piece of work produced with a view to modifying, expanding or restructuring it.

PS 2.3 CHECK AND DESCRIBE RESULTS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
check if the problem has been solved by applying given methods, describe the results and explain the approach to problem solving.	• apply accurately the methods given to check whether the problem has been solved successfully • describe clearly the results, and explain the decisions taken at each stage of tackling the problem • identify the strengths and weaknesses of the approach to problem solving and describe what would be done differently if a similar problem were met.	Records of the methods used, the results of the checks carried out and explanations of the decisions taken. Descriptions of the strengths and weaknesses of the approach to the problem solving activities, and what would be done differently in future.	Discuss with teacher the piece of work to ensure that the problem or issue has been addressed appropriately. Describe the results in a log of procedural research.

PROBLEM SOLVING: LEVEL 3

Candidates must provide at least **one** substantial example of meeting the standard of PS3.1, PS3.2 and PS3.3.

PS 3.1 EXPLORE PROBLEMS AND OPTIONS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
explore a complex problem, come up with **three** options for solving it and justify the options selected for taking it forward.	• explore the problem, accurately analysing its features, and agree with others on how to show success in solving it • select and use a variety of methods to come up with different ways of tackling the problem • compare the main features of each possible option, including risk factors, and justify the option selected to take it forward.	Description of the problem, the analysis of its features and methods used for exploring it Statements endorsed by appropriate people of how problem was going to be solved Descriptions of the **three** options for solving the problem, with notes on the methods used for coming up with these and comparisons of their main features A note to justify the chosen option.	Students identify a Scientific topic for an extended essay or coursework study and make notes or essay plans considering three ways of approaching it. This could involve group/class discussion of aspects/ approaches and of possible sources of information (e.g. alternative ways of finding information). The topic might itself contain a problem on which there are different Scientific perspectives. Justify the selected approach to be used.

PS 3.2 PLAN AND IMPLEMENT OPTIONS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
plan and implement at least **one** option for solving a problem, review progress and revise approach as necessary**.**	• plan how to carry out the chosen option and obtain agreement to go ahead from an appropriate person • implement plan, effectively using support and feedback from others • review progress towards solving the problem and revise approach as necessary.	A plan, with notes of changes made, and endorsed statement of how agreement to go ahead with chosen option was obtained Records of how plan is implemented, including how support and feedback was used and how progress was reviewed.	Present notes or essay plan which is discussed with the teacher and then executed e.g. through the writing of a piece of coursework or essay. Review the piece of work produced with a view to modifying, expanding or restructuring it.

PS 3.3 CHECK AND REVIEW APPROACH			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
apply agreed methods to check if the problem has been solved, describe the results and review approach to problem solving.	• agree, with an appropriate person, methods to check if the problem has been solved • apply these methods accurately, draw conclusions and fully describe the results • review approach problem solving, including whether alternative methods and options might have proved more effective.	Description of the methods used, the results and conclusions Records of review, including notes of any alternative methods and options which might be predicted to have been more effective.	Discuss with teacher the piece of work to ensure that the problem or issue has been addressed appropriately. Describe the results in a log of procedural research and review the approach used.

WORKING WITH OTHERS: LEVEL 1

Students must provide at least **one** example of meeting the standard for WO1.1, WO1.2 and WO1.3

- **one** example must show work in one-to-one situations
- **one** example must show work in group situations

WO 1.1 CONFIRM WHAT TO DO			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
confirm what needs to be done to achieve given objectives, including responsibilities and working arrangements.	• check understanding of the objectives the student has been given for working together • identify what needs to be done to achieve them and suggest ways the student could help • make sure that the student is clear about her/ his responsibilities and working arrangements.	Records from someone who observed the student's discussions with others or audio/video tapes. Notes of the objectives, responsibilities and working arrangements.	A group activity e.g. students contribute jointly to the planning of an experiment/ investigation.

WO 1.2 WORK TOWARDS OBJECTIVES			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
work with others towards achieving the given objectives, carrying out tasks to meet responsibilities.	• carry out tasks to meet responsibilities • work safely, and accurately follow the working methods the student has been given • ask for help and offer support to others, when appropriate.	Records of how the student carried out tasks to meet responsibilities. Notes of the help given and the support the student offered others. These records could include a log, statements written by others with whom the student worked, audio/video tape recordings, photographs with notes.	Students establish links with other members of the class to gather information/illustrations or produce texts/ diagrams/drawings. The exchange ideas with other members of the group.

WO 1.3 IDENTIFY PROGRESS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
identify progress and ways of improving work with others to help achieve given objectives.	• identify what has gone well and less well in working with others • report any difficulties in meeting responsibilities and what was done about them • suggest ways of improving work with others to help achieve objectives.	Statements (written or recorded). Records of answers to questions about any difficulties and what the student did about them. Notes of ways to improve work with others.	Review of the progress made in collecting and presenting the information or evidence reflecting on ways in which collaborative working could be improved.

WORKING WITH OTHERS: LEVEL 2

Students must provide at least **two** examples of meeting the standard WO2.1, WO2.2 and WO3.3

- **one** example must show working in one-to-one situations
- **one** example must show working in group situations

WO 2.1 PLAN WORK			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
plan straightforward work identifying objectives and clarifying responsibilities and confirm working arrangements.	• identify the objectives of working together and what needs to be done to achieve these objectives • exchange relevant information to clarify responsibilities • confirm working arrangements with those involved.	Records from someone who observed the student's discussions with others or audio/video tapes. Note of the information provided, with details of the identified objectives, responsibilities and working arrangements of those involved.	A class or group activity e.g. students plan and organise a presentation or debate on an aspect of Science e.g. genetic engineering.

WO 2.2 WORK TOWARDS OBJECTIVES			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
work co-operatively with others towards achieving the identified objectives, organising tasks to meet responsibilities.	• organise own tasks so the student can be effective in meeting responsibilities; • carry out tasks accurately and safely, using appropriate working methods • support co-operative ways of working, seeking advice from an appropriate person when needed.	Records of how the student organised and carried out tasks, supported co-operative work and sought advice. These records could include a log, statements written by others with whom the student worked, audio/video tape recordings, photographs with notes.	Students establish links with other members of the class to gather information/illustrations or produce texts/ diagrams/drawings. They exchange ideas with other members of the group.

WO 2.3 EXCHANGE INFORMATION ON PROGRESS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
exchange information on progress and agree ways of improving work with others to help achieve objectives.	• provide information on what has gone well and less well in working with others, including the quality of work • listen and respond appropriately to progress reports from others • agree ways of improving work with others to help achieve objectives.	Statements on progress (written or recorded) including details about the quality of work and how the student responded to other reports on progress. Notes of what the student agreed to do to improve work with others and help achieve objectives.	Review of the progress made in collecting and presenting the information or evidence reflecting on ways in which collaborative working could be improved.

WORKING WITH OTHERS: LEVEL 3

Students must provide at least **one** substantial example of meeting the standard for WO3.1, WO3.2 and WO3.3 in both one-to-one and group situations.

WO 3.1 PLAN WORK			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
plan complex work with others, agreeing objectives, responsibilities and working arrangements.	• agree realistic objectives for working together and what needs to be done to achieve them • exchange information, based on appropriate evidence to help agree responsibilities • agree suitable working arrangements with those involved.	Reports which describe how the student planned work with others, including objectives, responsibilities, and working arrangements. Records from someone who observed the discussions with others or audio/video tape.	A class or group activity e.g. students plan and organise a presentation or debate on an aspect of Science e.g. genetic engineering, allocating responsibilities to members of the group.

WO 3.2 WORK TOWARDS OBJECTIVES			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
seek to establish & maintain cooperative working relationships over an extended period of time, agreeing changes to achieve agreed objectives.	• organise and carry out tasks to show effectiveness and efficiency in meeting responsibilities and produce the quality of work required • seek to establish and maintain cooperative working relationships, agreeing ways to overcome any difficulties • exchange accurate information on progress of work, agreeing changes where necessary to achieve objectives.	Records of how the student organized and carried out tasks and maintained cooperative working relationships, including a progress report. These records could include a log, statements written by others with whom the student worked, audio/video tape recordings, photographs, or products made, with notes.	Students establish links with other members of the class to gather information/illustrations or produce texts/ diagrams/drawings. They exchange ideas with other members of the group and cooperate to meet agreed objectives.

WO 3.3 REVIEW WORK			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
review work with others and agree ways of improving collaborative work in the future.	• agree the extent to which work with others has been successful and the objectives have been met • identify factors that have influenced the outcomes • agree ways of improving work with others in the future.	Statements (written or recorded) from both the student and others on the extent to which the agreed objectives were achieved. Reports produced with others on ways to improve future collaborate work.	Review of the progress made in collecting and presenting the information or evidence reflecting on ways in which collaborative working could be improved.

IMPROVING OWN LEARNING AND PERFORMANCE: LEVEL 1

The candidate must provide at least **two** examples of meeting the standards for LP1.1, LP1.2 and LP1.3.

LP 1.1 CONFIRM TARGETS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
confirm understanding of targets and how these will be met, with the person setting them.	• make sure targets clearly show what is wanted to be achieved • identify action points and deadlines for each target • make sure the dates for reviewing progress and how to get support needed are known.	Records of discussions which show the student checked her/his understanding of targets and knew how to get the support. Two action plans with action points, deadlines and dates for reviewing progress.	Establish with the teacher targets for enhancing performance. (e.g. identification of a topic and plan of action for a coursework study).

LP 1.2 FOLLOW A PLAN			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
follow plans, using support given by others to help meet targets. Improved performance by • studying a straightforward subject • learning through a straightforward practical activity.	• work through the action points to complete tasks on time • use support given by others to help in the meeting of targets • use different ways of learning suggested by supervisor and make changes suggested by the person supervising the student, when needed.	A log of study-based and activity-based learning, with notes of the support given. Records from those who have seen the work and which shows the tasks were completed on time and how any suggested changes were made.	Produce a log showing stages of development of a coursework study in accordance with targets.

LP 1.3 REVIEW PROGRESS AND ACHIEVEMENTS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
review achievements and progress in meeting targets, with an appropriate person.	• say what it is thought has gone well and less well, what was learned and ways learning took place • identify targets met and evidence of achievements • check that the student understood how to improve.	Records of • what was said about the student's progress • her/his achievements • what to do to improve Examples of work which show the student learned from studying two subjects and two practical learning activities to show targets met.	Keep a portfolio of tasks which have been assessed during a course of study and how, possibly through a log, learning and performance have been improved from comments, both verbal and written, made by the teacher and others.

IMPROVING OWN LEARNING AND PERFORMANCE: LEVEL 2

The candidate must provide at least **two** examples of meeting the standard for LP2.1, LP2.2 and LP2.3.

LP 2.1 SET TARGETS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
help set short-term targets with an appropriate person and plan how these will be met.	• provide accurate information to help set realistic targets for achieving what is to be done • identify clear action points for each target • plan how time will be used effectively to meet targets, including use of support and a date for reviewing progress.	Records information provided to help set targets. Two action plans with action points, timetable and notes of support needed.	Establish with the teacher and/or others, through one-to-one and group discussion, targets for enhancing performance. (e.g. identification of a topic and plan of action for a coursework study).

LP 2.2 USE A PLAN			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
Take responsibility for some decisions about learning, using a plan and support from others to help meet targets. Improve performance by • studying a straightforward subject • learning through a straightforward practical activity.	• use action points to help manage time well and complete tasks • identify when support is needed and use this effectively to help the meeting of targets • select and use different ways of learning to improve performance.	A log of learning, with notes of: • when the student asked for support and it was used • when and how the student worked without close supervision • any changes made to the plan. Records from those who saw the work which show the student managed her/his time well and completed tasks.	Produce a log of procedural research, monitoring progress and how issues and problems were tackled in the context of study. Log should include details of how a straightforward topic or issue in Science was approached (e.g. gathering together evidence and sources for the assignment).

LP 2.3 REVIEW PROGRESS AND ACHIEVEMENTS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
review progress with an appropriate person and provide examples of evidence of achievements, including how learning was used from one task to meet the demands of a new one.	• identify what and how was learnt, including what has gone well and what has gone less well • identify targets met, and examples of evidence of achievements • identify ways of improving own performance.	Records of information provided on progress and ways of improving performance. Examples of work which show what was learned from two study-based and two activity-based learning activities. Notes on personal action plans to show targets met.	Keep a portfolio of tasks which have been assessed during a course of study and how, possibly through a log, learning and performance have been improved from comments, both verbal and written, made by the teacher and others.

IMPROVING OWN LEARNING AND PERFORMANCE: LEVEL 3

Candidates must provide at least **one** substantial example of meeting the standard for LP3.1, LP3.2 and LP3.3.

LP 3.1 AGREE TARGETS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
agree targets and plan how these will be met over an extended period of time, using support from appropriate people.	• seek information on the ways to achieve what they want and identify factors that might affect plans • use this information to agree realistic targets with appropriate people • plan how time will be effectively managed and use support to meet targets, including alternative action for overcoming possible difficulties.	Records to show how the student obtained and used information to agree targets An action plan for an extended period of time (eg. about three months) including alternative courses of action and a note of support needed.	Establish with the teacher and/or others, through one-to-one and group discussion, targets for enhancing performance. (e.g. identification of a topic and plan of action for an assignment).

LP 3.2 USE A PLAN			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:

• take responsibility for learning by using plan, seeking feedback and support from relevant sources, to help meet targets
• improve performance by:
  • studying a complex subject
  • learning through a complex practical activity
  • further study or practical activity involving independent learning.
	• manage time effectively to complete tasks, revising plan if necessary
	• seek and actively use feedback and support from relevant sources to meet targets
	• select and use different ways of learning to improve performance, adapting approaches to meet new demands.
		A log of learning, with notes of:
		• how the student learned in different ways and adapted his/her approach
		• when the student sought feedback and support and how he/she used it
		• any revisions made to the plan
		Records from those who have seen the work managed effectively and tasks were completed.
			Produce a log of procedural research, monitoring progress and how issues and problems were tackled in the context of study.
			
			Log should include details of how a topic or scientific issue was approached (e.g. gathering together evidence and sources for the assignment).

LP 3.3 REVIEW PROGRESS AND ACHIEVEMENTS			
Candidates must:	**Evidence must show candidates can:**	**Examples of evidence:**	**Suggested context**:
review progress on **two** occasions and establish evidence of achievement, including how learning from other tasks has been used to meet new demands.	• provide information on the quality of learning and performance, including factors that have affected the outcome • identify targets met, seek relevant sources to establish evidence of achievements • exchange views with appropriate people to agree ways to further improve performance.	Records of information provided by the student on his/her learning and performance, including how he/she used learning from other tasks to meet new demands Examples of work which show what the student learned from studying complex subjects, through practical activity and independent learning Records of discussions which show how the student sought evidence of his/her achievements and exchanged views on ways to improve performance Note on action plan to show targets that have been met.	Keep a portfolio of tasks which have been assessed during a course of study and how, possibly through a log, learning and performance have been improved from comments, both verbal and written, made by the teacher and others.