SPECIFICATION

For exams January, May and November onwards
For teaching from September 2021 onwards

Learning Resource Network

INTERNATIONAL AS AND A-LEVEL BIOLOGY (6011)

THE QUEEN'S AWARDS FOR ENTERPRISE: INTERNATIONAL TRADE 2020

Contents

BACKGROUND TO LRN

Learning Resource Network (LRN) is a recognised Awarding Organisation that offers a range of qualifications to candidates, educational institutes, training providers, schools and employers.

LRN is recognised for its high quality qualifications that enable candidates to progress to other areas of study and employment in their designated fields.

In producing its qualifications, LRN uses the experience and expertise of academics, professionals working in the pertinent industries and assessment practitioners with a wealth of best practice and knowledge of validation, verification, delivery and assessment.

ACCOLADES

Queen's Award

In April 2020, LRN received the Queen's Award for Enterprise for International Trade. LRN is one of 220 organisations in the UK to be recognised with this prestigious accolade. This was in recognition of the expansion LRN brought to the overseas qualification market.

MANAGEMENT SYSTEMS

LRN has been awarded international accreditation as part of its quality controls, policies, systems and overall approach to its management systems. These awards are externally validated by the British Assessment Bureau. LRN has achieved accreditation in the form of ISO 9001: Quality Management Systems, ISO 14001: Environment Management Systems and ISO 27001: Information Security Management Systems.

CUSTOMER SERVICE EXCELLENCE

LRN has achieved the prestigious award of Customer Service Excellence. This is in recognition of its customer service practices, approach to managing and dealing with UK and Overseas customer needs, including the diverse needs of its centres.

LRN was the first UK Awarding Organisation to achieve Customer Service Excellence.
Following reaccreditation in 2019, LRN received an award for Customer Service Excellence: Compliance Plus, demonstrating that LRN went above and beyond the delivery of its customer service principles.

INTRODUCTION

This specification provides an overview to the LRN International AS & A Level Biology[1]. This document is suitable for various users, including candidates, centres, administrators, employers, parents/guardians, teachers (and other educational based staff) and examiners. The specification outlines the key features and administrative procedures required for this international qualification.

OBJECTIVE

The LRN International AS & A Level Biology is designed to enable international candidates to demonstrate their ability, in both practical and theoretical terms across a range of: biological understanding, cell infrastructure, disease, immunity and genetics, along with bioenergetics, energy, ecosystems and variations and evolution.

MODE OF DELIVERY

This qualification has been constructed to be delivered within centres. Centres will need to demonstrate to LRN, through the centre recognition processes, that they have the resources, facilities and competence to deliver. However, centres must be able to demonstrate, in line with LRN's criteria, that they have the means, capability, capacity and resources (including suitably qualified centre staff) to deliver by the method chosen by the centre.

PROGRESSION

The LRN International AS & A Level Biology has been designed to reflect the wide variation in candidates' origins, levels of education and career aims. Progression opportunities may, therefore, take a variety of paths. Depending on the level of qualification achieved, it may be appropriate for the candidate to progress to:

1. Similar level 3 qualification in Biology;
2. LRN Level 3 Diploma in Pre-U Foundation Studies;
3. A higher level of any qualification – e.g.; HNC/HND or Degree'
4. Vocationally Related Qualifications

[1] LRN International AS/A Level are globally recognised qualifications designed specifically for international candidates and are available outside the United Kingdom. Candidates based in England refer to the Ofqual register.

QUALIFICATION OVERVIEW

Number	Subject Content	LRN International AS Level	LRN International A Level	AO	Exam
1	Biological molecules	√	√	1, 2 and 3	Combination of written exam papers (externally set and marked) and a practical demonstration of skills. **AS Level** **Paper 1:** Multiple Choice, Extended Theory, and practical based skills. Duration: 2 hours Weighting: 50% **Paper 2:** Multiple Choice, Extended Theory, and practical based skills. Duration: 2 hours Weighting: 50% **A Level** **Paper 1:** Multiple Choice, Extended Theory, and practical based skills. Duration: 2 hours Weighting: 40% **Paper 2:** Multiple Choice, Extended Theory and practical based skills. Duration: 2 hours Weighting: 40% **Paper 3:** Essay Questions Duration: 1 hour 15 minutes Weighting: 20%
2	Cell ultrastructure	√	√	1, 2 and 3	
3	Exchange of substances	√	√	1, 2 and 3	
4	Disease and immunity	√	√	1, 2 and 3	
5	Genetic information	√	√	1, 2 and 3	
6	Bioenergetics	-	√	1, 2 and 3	
7	Coordination in organisms	-	√	1, 2 and 3	
8	Energy and ecosystems	-	√	1, 2 and 3	
9	Genetics, variation, and evolution	-	√	1, 2 and 3	
10	Gene technologies	-	√	1, 2 and 3	

BREAKDOWN OF ASSESSMENT OBJECTIVES

AO1 - demonstrate knowledge and understanding of:

- scientific ideas
- scientific techniques and procedures

AO2 – apply knowledge and understanding of:

- scientific ideas
- scientific enquiry, techniques and procedures l

AO3 – analyse information and ideas to:

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

ASSESSMENT

The assessment for this qualification consists of (i) written exam papers, and (ii) practical demonstration of skills, set and marked by the LRN.

Assessment objectives (AOs)	Weighting		
	Paper 1	Paper 2	Paper 3
AO1	30%	30%	30%
AO2	40%	40%	50%
AO3	30%	30%	20%

GUIDED LEARNING HOURS (GLH)

The LRN International AS Level guided learning hours (GLH) are 180 and 360 guided learning hours for LRN International A Level. Please note the hours stated are indicative.

ENTRIES CODES

One entry per qualification is sufficient and will cover all the question papers including certification.

PRIVATE CANDIDATES

Centres are advised that private candidates are only to be enrolled with prior agreement and confirmation from LRN.

GRADING

The LRN International A Level will be graded on a six-point scale: A*, A, B, C, D and E and LRN International AS Level will be graded on a five-point scale: A, B, C, D and E Candidates who fail to reach the minimum standard for grade E will be recorded as U (unclassified) and will not receive a qualification certificate.

RESULTS

Exam series are in:

- January (results released in March)
- June (results released in August)
- November (results released in January)

RE-TAKES

Whereas candidates can re-take each paper as often as they wish, within the shelf-life of the specification.

CUSTOMER SERVICE STATEMENT

Learning Resource Network (LRN) is committed to ensuring all customers are dealt with promptly and in a professional and helpful manner. In order to guarantee this, we commit to ensuring the following in our day-to-day interactions with candidates, assessment centres and our stakeholder network:

- All customers will be treated equally and with respect.
- All customer information will only be used in a way which has been agreed in advance, unless we are informed of something that places them or others at risk of harm.
- All customers will be treated by staff in a professional manner.

LRN has arrangements in place to provide a telephone and e-mail helpdesk which will be staffed from 09:00 to 17:00 from Monday to Friday. Furthermore, it will respond to each e-mail, letter, or telephone message it receives regarding feedback on its qualifications, centre approvals process or other matters relating to its products and/or services. The timetable for responding is as follows:

- E-mail: 5 working days
- Letter: 5 working days
- Telephone message: 5 working days

DIVERSITY AND EQUALITY

Learning Resource Network (LRN) is committed to ensuring fair and equal access to its qualifications, examinations and support materials. Our Diversity and Equality policy seeks to eliminate unjustifiable discrimination, harassment and/or victimisation and to advance equality of opportunity, thereby ensuring all candidates are treated fairly, in accordance with the protected characteristics of the Equality Act 2010. Specifically, we comply fully with the requirements laid out in the Equality Act 2010. In addition, and within the constraints of this policy, LRN will have due regard for the General data Protection Regulations (GDPR) in the retention of information which is unnecessary.

1	**Biological molecules**		
Aim: To gain a better understanding of biochemical molecules in organisms and understand the chemical nature and properties.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand water and inorganic mineral ions.	1.1	**Summarise** the basis of water as a polar molecule.
		1.2	**Explain** the physical and chemical properties of water.
		1.3	**Analyse** the importance of water for living organisms, in terms of: (i) important metabolite, (ii) universal solvent, (iii) large latent heat of vaporisation, (iii) large heat capacity, (iv) cohesive and adhesive properties, and (v) hydrostatic pressure for marine organism's body support.
		1.4	**Summarise** various ions and their importance in living organisms, specifically: (i) calcium, (ii) iron, (iii) magnesium, (iv) nitrates, (v) phosphates, and (vi) hydrogen.
2	Understand monomers and polymers.	2.1	**Assess** the nature of various monomers and polymers in living organisms.
		2.2	**Describe** how condensation and hydrolysis reactions are involved in the formation and breakdown of polymers.
3	Understand the function of carbohydrates.	3.1	**Outline** common monomers of carbohydrates.
		3.2	**Summarise** the role fulfilled by monomers within carbohydrates.
		3.3	**Describe** the ring structure of properties of glucose.
		3.4	**Analyse** the chemical formula of saccharides.
		3.5	**Describe** differences between isomers of glucose alpha and beta.
		3.6	**Assess** the importance of type 1-4 and 1-6 glycosidic bonds in terms of structure and function of carbohydrate.
		3.7	**Compare** the chemical structure of glucose polymers, specifically: (i) starch, (ii) cellulose, and (iii) glycogen.

		3.8	**Analyse** the composition of monomers, bonding, and function in relation to (i) starch, (ii) cellulose, and (iii) glycogen.
		3.9	**Describe** how glycosidic bonds are formed and broken in the synthesis and hydrolysis or disaccharides and polysaccharides
4	Understand the role of proteins.	4.1	**Analyse** the role of amino acids as monomers of proteins.
		4.2	**Describe** the similarities of amino acids and monomers.
		4.3	**Describe** the structure of amino acids.
		4.4	**Analyse** the significance of the R group at determining the primary structure of dipeptides and polypeptides.
		4.5	**Analyse** the role of amino acids as monomers of proteins.
		4.6	**Assess** the similarities of amino acids and monomers.
		4.7	**Describe** the formation of peptide bonds
		4.8	**Summarise** the process by which peptide bonds are formed and broken by condensation and hydrolysis.
		4.9	**Examine** the process by which proteins are structured as bonding types, specifically: (i) hydrogen bonds, (ii)ionic bonds, and (iii) disulphide bridges.
		4.10	**Describe** the levels of protein structure including primary, secondary, tertiary and quaternary.
		4.11	**Summarise** globular and fibrous proteins.
		4.12	**Assess** the role fulfilled by fibrous proteins in relation to structure.
		4.13	**Describe** the role of enzymes in various metabolic reactions.
		4.14	**Compare** the stages of an enzyme catalysed reaction
		4.15	**Explain** how enzyme models have changed from “lock and key” to ‘induced fit model.

		4.16	**Explain** the impact of the following on enzyme catalysed reactions (i) effect of pH, (ii) temperature, (iii) substrate concentration, (iv) enzyme concentration, (v) competitive, and (vi) non-competitive inhibitors.
5	Understand the role of lipids.	5.1	**Analyse** the relationship between lipids and polymers.
		5.2	**Summarise** the following classes of lipids: (i) triglycerides, and (ii) phospholipids.
		5.3	**Describe** the roles fulfilled by triglycerides and phospholipids within organisms.
		5.4	**Differentiate** between saturated and unsaturated fatty acids related to chemical structure and function.
		5.5	**Assess** the role of ester bonds in terms of: (i) formation, (ii) impact from condensation, and (iii) hydrolysis between fatty acids and glycerol.
6	Understand the role of nucleic acids.	6.1	**Compare** DNA as a polymer in terms of its constituent components.
		6.2	**Assess** the role of phosphodiester bonds in terms of: (i) formation, (ii) impact from condensation, and (iii) hydrolysis between nucleotides.
		6.3	**Describe** DNA in terms of double helix structure, complimentary base pairing, strands run anti-parallel.
		6.4	**Explain** how complimentary base pairing takes place, specifically: (i) between purine and pyrimidine bases, and (ii) the formation of hydrogen bonds.
		6.5	**Summarise** the process of DNA replication.
		6.6	**Describe** how semi-conservative replication takes place in line with models proposed by Meselson and Stahl
		6.7	**Analyse** how DNA acts as a transforming agent between virulent and non- virulent bacteria.
		6.8	**Discuss** the required evidence for Watson's Crick Model of DNA.
7	Understand the role of Adenosine Triphosphate (ATP) and Adenosine Diphosphate (ADP) in biology.	7.1	**Compare** the roles fulfilled by ATP and ADP as nucleotides derivatives.
		7.2	**Describe** the reversible reaction involving the hydrolysis of ATP and when ATP is resynthesised.
		7.3	**Assess** the condition of inorganic phosphate during the hydrolysis of ATP.

8	Be able to demonstrate a practical ability regarding biological molecules.	8.1	**Draw** a condensation and hydrolysis reaction involving disaccharides and polysaccharides.
		8.2	**Produce** a serial dilution of glucose concentrations to create a calibration curve to identify the concentration of unknown solutions.
		8.3	**Carry out** a series of qualitative tests for carbohydrates.
		8.4	**Report** on the findings following the qualitative tests for carbohydrates.
		8.5	**Interpret** the results from qualitative tests for carbohydrates.
		8.6	**Carry out** a series of chromatography tests in order to separate a mixture of monosaccharides
		8.7	**Draw** a condensation and hydrolysis reaction involving dipeptides and polypeptides.
		8.8	**Use** chromatography to separate a mixture of amino acids and using Rf values to determine composition of an unknown mixture.
		8.9	**Carry out** a Biuret test for identifying presence of proteins.
		8.10	**Investigate** the effects of temperature, substrate concentration, and enzyme concentration, competitive and non-competitive inhibitors on enzyme catalysed reactions.
		8.11	**Carry out** an emulsion test for lipids.
		8.12	**Carry out a** DCPIP titration to identify the concentration of vitamin C of fruit juice.
		8.13	**Draw** the basic structure of triglycerides and phospholipids.
		8.14	**Draw** the general structure of DNA and RNA (rRNA, mRNA, tRNA)

2	**Cell ultrastructure**		
Aim: To gain an understanding of cell ultrastructure and how cells are observed and studied.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand cells	1.1	**Describe** the structure of eukaryotic cells, specifically organelles and their function of (i) animal, (ii) plant, (iii) fungi, and (iv) protoctists.
		1.2	**Describe** a range of specialised animal and plant cells and explain how they are adapted to perform specific roles.
		1.3	**Summarise** the structure of prokaryotic cells; including the organelles and their function.
		1.4	**Summarise** the endosymbiont theory.
		1.5	**Analyse** the levels of organisation found in multicellular organisms
		1.6	**Analyse** the structure of viruses and recognise them as non-living / acellular
		1.7	**Compare** differences between eukaryotic, prokaryotic and virus structures.
2	Understand the functions of a microscope.	2.1	**Assess** the need for microscopes to view cells and organelles.
		2.2	**Summarise** the terms magnification and resolution.
		2.3	**Describe** the processes involved for specimen preparation for a range animals and plants for an optical microscope.
3	Understand cell division.	3.1	**Analyse** how cells are formed through the division of existing cells.
		3.2	**Describe** the importance of mitosis and explain its role in eukaryotes.
		3.3	**Describe** the cell cycle including details of events during interphase, mitosis, and cytokinesis
		3.4	**Summarise** the stages of cell division, including (i) prophase, (ii) metaphase, (iii) anaphase, and (iv) telophase.

		3.5	**Explain** the process by which cells are replicated.
		3.6	**Summarise** the process of mutation which occur during cell division.
		3.7	**Analyse** how cancer treatments focus on reducing the rate of cell division.
		3.8	**Describe** the process of binary fission in bacteria.
		3.9	**Analyse** the replication process in a virus
		3.10	**Contrast** cell division in cells and viral replication.
4	Understand cell membranes and transport across cell membranes	4.1	**Describe** the role of membranes in cells including transport and cell recognition.
		4.2	**Examine** the fluid mosaic model of cell membrane including the role of cholesterol and various proteins.
		4.3	**Summarise** the terms (i) endocytosis, (ii) exocytosis, and (iii) pinocytosis.
		4.4	**Explain** transport across the membrane in terms of polar and non-polar molecules.
		4.5	**Summarise** differences in method of transport in polar and non-polar molecules.
		4.6	**Describe** the processes of (i) diffusion, (ii) facilitated diffusion, (iii) osmosis, and (iv) active transport.
		4.7	**Analyse** how factors such as surface area, number of channel/carrier proteins and water potential affect the rate of transport of substances.
		4.8	**Describe** the effects of (i) hypertonic, (ii) hypotonic, and (iii) isotonic solutions on animal and plant cells.
		4.9	**Examine** the process of active transport in terms of ion pumps and co-transport.
		4.10	**Assess** how temperature and pH can affect the permeability of the cell membrane.
5	Be able to demonstrate a practical application in relation to cell ultrastructure.	5.1	**Investigate** pH and temperature on the permeability of the cell surface membrane.
		5.2	**Investigate** the impact of serial dilution of a solute to produce a calibration curve to identify water potential inside plant cells.

		5.3	**Produce** a root tip specimen in order to calculate the mitosis index.
		5.4	**Calculate** actual size, image size and magnification from information provide or micro pictographs
		5.5	**Carry out** unit conversions between picometres, nanometres, micrometres, millimetres and centimetres
		5.6	**Prepare and stain** an animal / plant tissue for viewing using an optical microscope.
		5.7	**Use** a stage micro-meter and optical microscope to carry out a calibration to calculate action size.
		5.8	**Deduce** information from calibration of eye piece lens and micro-meter when using a light microscope to calculate actual size of a specimen.
		5.9	**Calculate** mitotic index from images.
		5.10	**Determine** microscope used from viewing a micro pictograph
		5.11	**Draw** and key structures within the cell membrane from diagrams.
		5.12	**Deduce** the method of transport of a substance across the cell membrane.

3	Exchange of substances		
Aim: To gain a better understanding of how substances are exchanged between organisms and environments, with understanding of how substances are transported within an organism.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand the exchange of substances between organisms and the environment.	1.1	**Describe** the relationship between surface areas to volume ratio in organisms and relative size.
		1.2	**Analyse** the ability of larger organisms require transport systems to be able to exchange substances involved in metabolic reactions.
		1.3	**Analyse** trends in structures of organisms that are adapted to carry exchange of substances between their environments.
2	Understand the process of gaseous exchange in animals.	2.1	**Analyse** the structures found in the gas exchange system of an insect in terms of: (i) tracheal system, (ii) tracheae, (iii) tracheae, (iv) tracheoles, and (v) spiracles.
		2.2	**Explain** the adaptations of the fish gas exchange system in terms of promoting diffusion.
		2.3	**Differentiate** features within structures, specifically (i) distribution of cartilage, (ii) cilia, (iii) goblet cells, and (iv) associated blood vessels.
		2.4	**Describe** the ability of activities at individual and governmental levels are capable of reducing the sources of risk factors.
		2.5	**Evaluate** information associated with risk factors and the incidence of lung cancer.
		2.6	**Differentiate** between correlation and causation.
		2.7	**Analyse** the steps involved leading to ventilation of mammalian lungs.
		2.8	**Summarise** gaseous exchange in mammals in terms of: (i) larynx, (ii) trachea, (iii) bronchi, (iv) bronchioles, and (v) alveoli.
		2.9	**Describe** health effects due to inhalation of tobacco smoke and air pollution on the lungs and heart disease.

3	Understand the process of gaseous exchange in plants.	3.1	**Analyse** the processes involved in opening and closing the stomata.
		3.2	**Explain** the adaptations of the internal structures of the leaf to promote gas exchange.
		3.3	**Summarise** factors that affect the rate of transpiration
4	Understand mass transport in animals.	3.4	**Summarise** the term mass transport as the movement of substances to and from exchange surfaces in plants and animals.
		3.5	**Describe** the internal and external structures of the mammalian heart in terms of atria, ventricles, septum, valves and main blood vessels.
		3.6	**Explain** structural adaptations related to function of arteries, arterioles, veins, venules and capillaries.
		3.7	**Summarise** the function of blood composition within main blood vessels in the body.
		3.8	**Distinguish** between blood vessels including pulmonary, hepatic, renal, and coronary vessels.
		3.9	**Compare and contrast** the single and double circulatory system.
		3.10	**Describe** the fish's circulatory system as a single circulatory system.
		3.11	**Examine** the mammalian circulatory system as a double circulatory system.
		3.12	**Explain** structural differences between the left and right side of the heart.
		3.13	**Explain** how a single heartbeat is initiated and controlled including details of sinoatrial node, atrioventricular node, punkye fibres and bundle of His
		3.14	**Describe** the cardiac cycle.
		3.15	**Analyse** changes in pressure and volume during the cardiac cycle.
		3.16	**Describe** the purpose of plasma in the blood.
		3.17	**Differentiate** between blood, tissue fluid and lymph.
		3.18	**Describe** the formation of tissue fluid and its return to the circulation

		3.19	**Describe** various components of the blood and identify them from micro – pictographs including red blood cells, monocytes, neutrophils, and lymphocytes
		3.20	**Analyse** haemoglobin as a globular protein with a prosthetic group of iron.
		3.21	**Describe** the role of Hb and red blood cells in the transport of oxygen in mammals
		3.22	**Describe** and explain the importance of red blood cell count of humans at high altitudes
		3.23	**Describe** and explain various health risks for heart disease.
		3.24	**Evaluate** information associated with risk factors and the incidence heart disease
		3.25	**Explain** differences between correlation and causation.
		3.26	**Describe** the ability of activities at individual and governmental levels are capable of reducing the sources of risk factors
4	Understand the method of transport in plants.	4.1	**Describe** structural differences between xylem vessels and phloem vessels related to function
		4.2	**Analyse** the arrangement and role of phloem and xylem in dicotyledonous plants in roots and stems.
		4.3	**Assess** the movement of water into the plant (including the symplastic and apoplastic pathways and Casparian strip).
		4.4	**Describe** the movement of water through the xylem vessels and explain the cohesion-tension hypothesis.
		4.5	**Analyse** the importance of sucrose as a transport molecule.
		4.6	**Describe** the process of translocation. Including companion cells, active loading, hydrostatic pressure and from source to sink.
		4.7	**Describe** and explain factors that affect the rate of transpiration.
5	Understand digestion and absorption.	5.1	**Examine** the important of mechanical and chemical digestion in mammals.
		5.2	**Assess** the functions performed by the following: (i) lipase, (ii) bile, (iii) endo and exopeptidases.
		5.3	**Describe** the adaptions of the villi.

		5.4	**Examine** the process of co-transport for amino acids and monosaccharides.
		5.5	**Assess** the role of micelles in lipid absorption.
6	Be able to demonstrate a practical application regarding the exchange of substances.	6.1	**Investigate** the effect of named variable enzyme catalysed reaction.
		6.2	**Construct** a model to investigate absorption of products of digestion
		6.3	**Carry out a** dissection of gas exchange system of an animal.
		6.4	**Use** a light microscope to examine gas exchange surfaces in animals.
		6.5	**Carry out a** dissection of a mammalian heart.
		6.6	**Investigate** a named variable on heart rate. e.g., caffeine of Daphnia.
		6.7	**Use** of a potometer to investigate a named variable effect on transpiration.
		6.8	Interpret an ECG and deduce various stages of the cardiac cycle
		6.9	**Use** a respirometer to measure volume of air involved in gas exchange using equation PVR = tidal volume x breathing rate.
		6.10	**Sketch** the oxyhaemoglobin dissociation curve in terms of cooperative binding and the Bohr Effect

4	**Disease and immunity**		
Unit: To gain a better understanding of diseases and how prevention and treatments can be used to fight against disease.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand disease	1.1	**Distinguish** difference between communicable (infectious) and non-communicable (non-infectious) diseases.
		1.2	**Identify** the common and species name and type of pathogen responsible for a range of conditions including: Malaria, cholera, tuberculosis, HIV/AIDs, measles, smallpox, and polio.
		1.3	**Describe** transmission of conditions listed above: Malaria, cholera, tuberculosis, HIV/AIDs, measles, smallpox, and polio.
		1.4	**Describe** symptoms of the following conditions: Malaria, cholera, tuberculosis, HIV/AIDs, measles, smallpox, and polio.
		1.5	**Explain** appropriate prevention and treatments for the following conditions: Malaria, cholera, tuberculosis, HIV/AIDs, measles, smallpox, and polio.
		1.6	**Evaluate** the effectiveness of prevention and treatments for the following conditions: Malaria, cholera, tuberculosis, HIV/AIDs, measles, smallpox, and polio.
		1.7	**Describe** how antibiotics are effective against bacteria but not viruses.
		1.8	**Explain** how bacteria become resistant to antibiotics due to mutation and natural selection.
		1.9	**Discuss** the challenges faced by growing numbers of antibiotic resistant bacteria.
		1.10	**Describe** suitable solutions to the growing antibiotic resistant bacteria
		1.11	**Explain** the phases of bacterial growth curve and calculate exponential growth rate.

2	Understand immunity.	2.1	**Describe** the nature of cell-to-cell recognition by receptors to distinguish between self and non-self (foreign) cells and antigens
		2.2	**Explain** antigen variability
		2.3	**Describe** non-specific and specific responses against pathogens in animals.
		2.4	**Describe** the process of phagocytosis.
		2..5.	**Describe** the role of B and T lymphocytes in specific immunity
		2.6	**Describe** the process of hybridoma cells in monoclonal antibody production.
		2.7	**Evaluate** the use of hybridoma cells and use of monoclonal antibodies as methods of treatment
		2.8	**Differentiate** between naturally acquired, artificially acquired, active and passive immunity.
		2.9	**Interpret** from information primary and secondary immune response from information provided.
		2.10	**Describe** the condition myasthenia gravis.
		2.11	**Describe** the process of vaccination in the fight against disease.
		2.12	**Evaluate** effectiveness of vaccination programmes at preventing disease.
		2.13	**Evaluate** information provided about the development and use of vaccine.
3	Be able to demonstrate a practical application in relation to genetics, variation, and evolution.	3.1	**Investigate** aseptic techniques through bacterial growth and antibiotic concentrations.

5	**Genetic information:**		
Aim: To gain a better understanding of DNA, its importance to the survival of organisms and methods of identifying historic trends in organisms.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand DNA and protein synthesis	1.1	**Describe** the difference in prokaryote and eukaryote DNA.
		1.2	**Identify** that mitochondria and chloroplasts have DNA and discuss its importance.
		1.3	**Describe** relative structure of chromosomes from nucleotide to chromosome in organisation.
		1.4	**Understand** the importance of a gene as the base sequence of DNA that codes for a specific amino acid sequence.
		1.5	**Describe** and explain DNA in terms of being universal, degenerate, triplet code, non-overlapping, linear nature.
		1.6	**Deduce** the corresponding complimentary sequence of bases between DNA, mRNA and tRNA.
		1.7	**Describe** in detail the process of transcription in the formation of Pre- mRNA including names of enzymes, bonds broken and formed.
		1.8	**Describe** and explain the differences between introns and exons and the process of gene splicing.
		1.9	**Compare** and contract transcription in eukaryote and prokaryote cells.
		1.10	**Describe** the process of translation
		1.11	**Deduce** the sequence of amino acids of a polypeptide from an mRNA base sequence.
		1.12	**Describe** the term gene mutation
		1.13	**Describe** and explain the various types of mutation as deletion, addition, and substation.

		1.14	**Describe** causes of gene mutations by mutagens and recognise the importance of DNA being degenerate.
		1.15	**Evaluate** the impact of each type of mutation and explain its impact on a translation.
2	Understand genetic diversity	2.1	**Describe** how genetic diversity arises from mutation and meiosis.
		2.2	**Understand** the terms crossing over and random assortment.
		2.3	**Describe** the process of meiosis.
		2.4	**Compare** and contrast the process of mitosis and meiosis.
		2.5	**Describe** mitosis and meiosis in terms of asexual and sexual reproduction and explain each type of cell division's role in an organism's survival.
		2.6	**Describe** and explain the process of non-disjunction and the impact on offspring.
		2.7	**Explain** the importance of genetic diversity in the process of natural selection of a species.
		2.8	**Describe** how genetic diversity leads to phenotypic variation.
		2.9	**Understand** the term fitness in context.
		2.10	**Describe** and explain the process of natural selection leading to evolution
		2.11	**Describe** the difference between directional and stabilising selection.
		2.12	**Interpret** information to deduce the types of selection observed.
3	Understand classification and species diversity.	3.1	**Distinguish** the various taxonomic hierarchy of domain, kingdom, phylum, class, order, family, genus, and species.
		3.2	**Describe** the main features of the five kingdoms.
		3.3	**Describe** and explain why viruses are not included the three-domain classification.
		3.4	**Outline** how viruses are classified.
		3.5	**Describe** and explain how genetic diversity in organisms can be assessed.

		3.6	**Interpret** similarities and differences between organisms to evaluate relationships between individuals of the same and different species.
		3.7	**Describe** how technology has developed to gain better understanding of DNA base sequencing.
		3.8	**Define** the term species.
		3.9	**Describe** and explain the formation of a hybrid and understand the term hybrid infertility
		3.10	**Describe** and explain the binomial naming system for classification of a species
		3.11	**Describe** the biological classification of species in taxonomic hierarchy.
		3.12	**Describe** and explain the importance of genome sequencing in classifying organisms and constructing evolutionary diagrams

6	**Bioenergetics**		
Aim: To gain a better understanding of the release and use of energy in organisms including key metabolic reactions.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand respiration	1.1	**Explain** the role respiration has in organisms and the role of ATP in the metabolism.
		1.2	**Describe** the internal structure and function of the mitochondria.
		1.3	**Describe** the process of glycolysis and appreciate as an anaerobic pathway.
		1.4	**State** the chemical equation for glycolysis and the net ATP and $NADH_2$ of the reaction.
		1.5	**Describe** the processes of anaerobic respiration in yeast (fermentation) and in mammal cells in the production of lactic acid.
		1.6	**Describe** the steps of aerobic respiration following glycolysis, the link reaction, Krebs cycle, electron transport chain and ATP synthesis
		1.7	**Describe** the relevant equations of the steps above including the roles of enzymes, and net yield of ATP synthesised.
		1.8	**Describe** the use of other substrates which are used of the Kreb's cycle
2	Understand photosynthesis	2.1	**Describe** the ultrastructure of a chloroplast.
		2.2	**Identify** the location of carbon fixation and light capture in chloroplasts.
		2.3	**Describe** the light dependent reaction and where it occurs.
		2.4	**Explain** the role of chlorophyl pigments in light capture of different wavelengths
		2.5	**Describe** the process of photolysis and its importance for photosynthesis.
		2.6	**Describe** the process of cyclic and non-cyclic photophosphorylation.
		2.7	**Describe** the light independent reaction in detail and where it occurs.

		2.8	**Describe** the reformation of RuBP.
		2.9	**Describe** the fate of triose phosphate synthesised in the Calvin cycle.
		2.10	**Understand** Hill's experiment and Calvin's lollipop experiment
		2.11	**Describe** factors that affect the rate of photosynthesis.
		2.12	**Describe** the internal structure of a leaf and adaptations for photosynthesis
		2.13	**Identify** various sections of a leaf from a micro pictograph.
3	Be able to demonstrate a practical application in relation to bioenergetics.	3.1	**Investigate** the effect of a named variable on respiration e.g., yeast, measuring the volume of carbon dioxide produced over time.
		3.2	**Isolate** chloroplasts.
		3.3	**Using** chromatography investigate various pigments of different plants.
		3.4	**Investigate** factors that affect photosynthesis by measuring oxygen produced by pond weed over time.
		3.5	**Using** a redox indicator and suspension of chloroplasts Investigate the effect of light intensity or light wavelength on the rate of photosynthesis.
		3.6	**Calculate** Rf values of various pigments using chromatography

7	**Coordination in organisms**		
Aim: To gain a better understand of how organisms detect and respond to changes in environment.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand response to stimuli	1.1	**Describe** the purpose of stimuli and responses by organisms to improve survivability in a habitat. Including details on taxes, kinases, and tropisms.
		1.2	**Explain** positive and negative tropisms in plants including phototropism, gravitropism, and hydrotropism
		1.3	**Describe** the action of auxin in plant responses in shoot and root
		1.4	**Describe** the central nervous system and peripheral nervous system in mammals
		1.5	**Explain** the reflex arc with examples of reflex actions to avoid damage to body cells.
		1.6	**Describe** relative structure of the Pacinian corpuscle and explain its including leading to the production of generator potentials.
		1.7	**Describe** the role of rod and cone cells in the eye
		1.8	**Compare** and contrast rod and cone cells in terms of shape, number, distribution, location, visual acuity, wavelength detection and light intensity sensitivity.
		1.9	**Describe** the autonomic system with reference to controlling heart rate.
		1.10	**Explain** the role of chemical and pressure receptors in controlling heart rate.
2	Understand nervous coordination and muscles as effectors	2.1	**Compare and contrast** nervous and hormonal systems in terms of method of transmission, rate of transmission, response time, duration, and reversibility.
		2.2	**Describe** the structure of mammalian neurone including cell body dendrons, axons, nodes of Ranvier, Schwann cells and myelin sheath.
		2.3	**Explain** the term resting potential.
		2.4	**Describe** the term action potential.

		2.5	**Describe** an axon membrane potential difference graph from resting potential to action potential to hyper-polarisation and returning to resting potential
		2.6	**Analyse** how an actional potential passes along a myelinated and unmyelinated axon.
		2.7	**Summarise** what is meant by the concept 'all or nothing principle'.
		2.8	**Describe** factors that affect the speed of impulse condition.
		2.9	**Describe** the refractory period and its purpose.
		2.10	**Describe** the structure of synapse and the functions they perform.
		2.11	**Describe** the term spatial and temporal summation
		2.12	**Describe** what is meant by the term inhibitory synapses
		2.13	**Explain** how information is transmitted across a synapse.
		2.14	**Describe** the effect of drugs on the functioning of a synapse.
		2.15	**Describe** the microscopic structure of skeletal muscle.
		2.16	**Compare and contrast** a neuromuscular junction and a cholinergic synapse.
		2.17	**Describe** the role of actin, myosin, calcium ions, and ATP in the contraction of myofibril.
		2.18	**Explain** the sliding filament mechanism.
		2.19	**Identify** from diagrams and explain sarcomeres in a relaxed and contracted muscle, including the A-band, I-band, H-zone, and Z line.
		2.20	**Differentiate** between slow- twitch and fast twitch fibres.
		2.21	**Examine** where the source of energy for muscle contraction.
		2.22	**Describe** muscle fatigue
3	Understand homeostasis and chemical coordination	3.1	**Describe** the term homeostasis.

		3.2	**Describe** the negative feedback mechanisms of each of the internal environment conditions stated above.
		3.3	**Explain** the importance of homeostasis at controlling a stable internal environment for blood pH, water, temperature, and glucose concentration
		3.4	**Describe** how hormones are involved in chemical responses by acting as chemical signalling molecules on target organs.
		3.5	**Describe** the term positive feedback with examples.
		3.6	**Assess** the impact of Glucoregulation and its regulation in the body.
		3.7	**Describe** the terms glycogenolysis, glycogenesis and gluconeogenesis.
		3.8	**Describe** the role of ATP in conversion of glycogen to glucose.
		3.9	**Evaluate** treatments for kidney diseases and their effectiveness.
		3.10	**Describe** the process of dialysis
		3.11	**Describe** the two main types of diabetes and explain how they various treatments help control blood glucose levels.
		3.12	**Analyse** fluctuation of glucose concentration in the blood.
		3.13	**Describe** and explain osmoregulation and its regulation in the body.
		3.14	**Describe** the ultrastructure of the nephron.
		3.15	**Describe** the processes that occur between blood entering the glomerulus and the final filtrate that leaves the kidney via the ureter.
		3.16	**Describe** the role of the liver in Glucoregulation
4	Be able to demonstrate a practical application in relation to coordination in organisms.	4.1	**Dissect** a mackerel to observe slow and fast twitch fibre's location on the body.
		4.2	**Investigate** muscle fatigue by repeated muscle contraction

8	**Energy and ecosystems**		
Aim: To gain a better understanding of interactions between abiotic and biotic factors in an ecosystem and threat facing organisms and suitable strategies to reduce stress on an organism's habitat.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand energy and ecosystems.	1.1	**Analyse** the different levels of biodiversity in an ecosystem.
		1.2	**Understand that and ecosystem is the interaction of biotic and abiotic factors in a community.**
		1.3	**Evaluate** the importance of photosynthetic organisms in an ecosystem.
		1.4	**Describe** and explain the transfer of energy through a community of organisms.
		1.5	**Describe** and explain energy loss from a ecosystem
		1.6	**Understand** that calorimetry can be used to calculate chemical energy stored in biomass.
		1.7	**Describe** and explain what is meant by gross primary productivity and net primary productivity and the equation NPP = GPP – R (R = respiration)
		1.8	**Describe** and explain the inefficiencies of energy transfer through the trophic levels/
		1.9	**Explain** how productivity can be determined by farming inputs, and a reduction of respiratory losses prior to human consumption.
2	Understand nutrient cycling	2.1	**Describe** the importance of nutrient recycling in an ecosystem.
		2.2	**Summarise** the importance of Sabrioants in the process of nutrient cycling.
		2.3	**Describe** and explain the processes involved in recycling carbon, water, nitrogen, and phosphorus.
		2.4	**Analyse** the importance of these nutrients to living organisms.
		2.5	**Examine t**he impact of chemical inputs to environments including fertilisers and pesticides.

		2.6	**Analyse** environmental effects of intensive farming practice e.g., eutrophication, salinization, destruction of habitats, disruption to food chains and webs, reduction of biodiversity, impacts on the water cycle.
		2.7	**Evaluate** the balance between conservation and farming.
		2.8	**Describe** suitable methods to reduce the environmental impact on farming.
3	Understand populations in ecosystems	3.1	**Describe** what is meant by the term ecosystem, community, niche, biodiversity, species, population, competition, fitness, biotic and abiotic factors.
		3.2	**Explain** factors that affect populations size.
		3.3	**Describe** the influence biotic and abiotic factors influence an ecosystem.
		3.4	**Explain** the need for over population of offspring to ensure species survival.
		3.5	**Interpret** phases of population growth curve.
		3.6	**Summarise** different phases of population growth curve.
		3.7	**Explain** the predator-prey relationship
		3.8	**Describe** the term carrying capacity.
		3.9	**Examine** the demographic transition model identifying changes in human population through time.
		3.10	**Describe** examples of interspecific and intraspecific interactions in an ecosystem.
		3.11	**Describe** various methods of sampling that can be used to investigate population size including quadrats, mark and recapture, line and belt transects
		3.12	**Assess** the process of vegetation succession from the point of colonisation by pioneer species to climax community.
		3.13	**Explain** the differences between primary and secondary succession
		3.14	**Describe** how conservation may affect the succession process
		3.15	**Describe** the term sustainability.

		3.16	**Evaluate** the importance of conservation
		3.17	**Describe** the following methods to support conservation: (i) sustainable forestry, (ii) sustainable fishery, (iii) aquaculture, (iv) zoos, (v) seed banks, (vi) assistant surrogacy, (vii) artificial insemination, (viii) national parks / nature reserves, (ix) action by NGOs such as World Wildlife Fund (WWF), (x) prevention of overpopulation, (xi) restoration or degraded habitats, (xii) reforestation programmes.
		3.18	**Evaluate** the effectiveness and discuss advantages and disadvantages of each method in local and global contexts.
4	Be able to demonstrate a practical application in relation to energy and ecosystems .	4.1	**Use** calorimetry to determine NPP of plant biomass.
		4.2	**Use** the following equations in context (i) Spearman Rank Collection, (ii) Pearson's Index, (iii) Lincoln Index, and (iv) Simpsons Biodiversity Equation.
		4.3	**Deduce** a suitable method of sampling based on information provided
		4.4	**Investigate** distribution of a species in a habitat and the effect of a named environmental factor e.g., pollution, pH, water, light, temperature.
		4.5	**Use** mark recapture method to estimate population size of a motile species.
		4.6	**Use** quadrat, belt or line transect to estimate population of non-motile species.
		4.7	**Calculate** secondary production using the equation N = I (F = R).
		4.8	**Calculate** the efficiency of energy as transferred through the trophic levels.

9	**Genetics, variation, and evolution**		
Aim: To gain a better understanding of genetics and how it can be used in determining variation in offspring, and its uses in supporting the theory of evolution.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand inheritance	1.1	**Summarise** the process of meiosis and mitosis its importance in the passing of hereditary information to the next generation.
		1.2	**Analyse** the importance of meiosis and mitosis in the transmission of hereditary information to the next generation.
		1.3	**Describe** what is meant by the terms: (i) genotype, (ii) phenotype, (iii) genes, (iv) locus, (v) alleles, (vi) autosomal linkage, (vii) sex linkage, (viii) pedigree diagrams, (ix) trait, (x) cross, (xi) homozygous, (xii) heterozygous, (xiii) dominant, (xiii) codominant, (xv) recessive, and (xvi) carrier F1 and F2 generation.
		1.4	**Compare** how species may exist as a one of more populations.
		1.5	**Describe** the effect of mutant alleles on the population's phenotype such as: (i) albinism, (ii) sickle cell anaemia, (iii) haemophilia, and (iv) Huntington's disease.
		1.6	**Describe** what is meant by the term gene pool.
		1.7	**Explain** the term allele frequency within a population.
		1.8	**Assess** the effect of allele frequency on the following factors: (i) mutation, (ii) sexual reproduction, (iii) gene flow, (iv) natural selection, and (v) genetic drift on
		1.9	**Describe** the conditions to allow for genetic equilibrium in a population.
		1.10	**Explain** the Heidy Weinberg principle as a model for genetic equilibrium.
2	Understand variation and evolution	2.1	**Summarise** types of discontinuous and continuous variation within a species and between species.
		2.2	**Describe** how an environment can influence phenotype of organisms.
		2.3	**Explain** the importance of genetic variation to the survival of a species.

		2.4	**Analyse** how genotype and environment can contribute to changes in phenotype variation.
		2.5	**Examine** the role of mutation and sexual reproduction in creating new allele combinations.
		2.6	**Describe** the process of natural selection on allele frequencies in gene pools.
		2.7	**Explain** the role of (i) stabilising, (ii) directional, and (iii) disruptive selection.
		2.8	**Analyse** the process of natural selection as a mechanism for evolution.
		2.9	**Assess** how a change evolution impacts on allele frequency within a population.
		2.10	**Describe** how geographical isolation can lead to natural selection occurring differently leading to genetic divergence and formation of a new species.
		2.11	**Explain** how sympatric speciation occurs.
		2.12	**Differentiate** between allopatric and sympatric speciation.
		2.13	**Analyse** the importance of genetic drift as part of evolution of small populations
		2.14	**Describe** the terms: (i) genetic bottleneck, and (ii) the founder effect.
		2.15	**Evaluate** the importance of evolution over a long time and the importance of genetic diversity of a species.
3	Be able to demonstrate a practical application in relation to genetics, variation, and evolution.	3.1	**Draw** genetic diagrams to represent monohybrid and dihybrid inheritance.
		3.2	**Using** the chi squared test to describe significance in observed and expected results of genetic crosses.
		3.3	**Calculate** the allele frequencies of alleles, genotypes and phenotypes in a population using Heidy Weinberg equation
		3.4	**Use** a t – test to compare variation of two different populations
		3.5	**Draw** sex linkage, autosomal linkage, gene interactions, epistasis, and polygenic inheritance.
		3.6	**Deduce** the offspring probability from information provided using genetic crosses

10	Gene technologies		
Aim: To gain a better understanding of genetic technology.			
Learning Outcomes - The learner will:		**Assessment Criteria - The learner can:**	
1	Understand gene expression.	1.1	**Describe** the term stem cells.
		1.2	**Summarise** the following terms: (i) unipotent, (ii) multipotent, and (iii) pluripotent stems and their medical applications.
		1.3	**Describe** the medical applications for (i) unipotent, (ii) multipotent, and (iii) pluripotent stems.
		1.4	**Explain** the term potency in terms of cells ability to differentiate.
		1.5	**Analyse** what is meant by induced pluripotent stem cells.
		1.6	**Describe** the process of micropropagation.
		1.7	**Summarise** the process of (i) DNA methylation, (ii) histone modification, and (iii) chromatin remodelling.
		1.8	**Describe** the term genomic imprinting.
		1.9	**Explain** the impact of methylation on DNA and its ability to influence the phenotype of organisms.
		1.10	**Summarise** the importance of epigenetic factors and phenotype.
		1.11	**Describe** the term mutation, in relation to (i) deletion, (ii) addition, (iii) substitution, and (iv) inversion
		1.12	**Analyse** the effects of mutation on polypeptide sequences.
		1.13	**Describe** the term frame shift in context.
		1.14	**Summarise** the terms: (i) inversion, (ii) duplication, and (iii) translocation as mutations involving larger segments of DNA.

		1.15	**Examine** the role of transcription factors in gene expression.
		1.16	**Explain** the role of oestrogen in transcription, the AID gene leading to cancer.
		1.17	**Describe** the role of RNA interference in gene expression.
		1.18	**Examine** the forms of cancer in terms of (i) oncogenes, (ii) tumour suppressor genes p53, and (iii) proto-oncogenes.
		1.19	**Evaluate** the importance on understanding oncogenes and tumour suppressor genes in preventing and treating cancers.
		1.20	**Evaluate** correlation and causation of risk factors associated with forms of cancer.
2	Understand gene technology.	2.1	**Evaluate** the importance of the genome project in terms of: (i) gene functions, (ii) evolution, (iii) bioinformatics, and (iv) medicine
		2.2	**Describe** the impact of The Human Genome Project
		2.3	**Assess** the following issues regarding the use of DNA technologies in industries: (i) social, (ii) economic, and (iii) ethical issues.
		2.4	**Describe** the term gene therapy including vectors and transformation of cells.
		2.5	**Analyse** the process of making recombinant DNA.
		2.6	**Explain** the process of in vivo gene cloning.
		2.7	**Describe** how to make synthetic DNA and its uses
		2.8	**Outline** the uses of synthetic DNA.
		2.9	**Describe** DNA probes and DNA hybridisation in locating alleles.
		2.10	**Analyse** how gene probes can be used to identify: (i) genetic conditions, (ii) responses to drug, and (iii) other potential health risks.
		2.11	**Analyse** the purpose of electrophoresis gels in determining genetic variation and relationships.
		2.12	**Describe** the function of gel electrophoresis.

		2.13	**Evaluate** the benefits of information provided by genetic screening.
		2.14	**Describe** genetic screening and its involvement in embryo selection
		2.15	**Assess** the role of ethics associated with pre-implantation genetic diagnosis.
		2.16	**Summarise** the process of DNA amplification and using PCR
		2.17	**Describe** the process of DNA amplification and using PCR.
		2.18	**Explain** the importance and uses of PCR
		2.19	**Analyse** the applications for DNA profiling using PCR, in relation to: (i) forensics, (ii) drug response, (iii) paternity, and (iv) identifying breed and relationship of organisms.
		2.20	**Assess** the function of DNA profiling.

APPENDIX:

CORE PRACTICAL COMPETENCIES:

Candidates will need to carry out and evidenced internally carried out practical's that include a range of the 5 representative competencies.

Competencies:

1. Follows written instructions:

a. Correctly follows written instructions to carry out experimental techniques or procedures.

2. Applies investigative approaches and methods when using instruments and equipment

a. Correctly uses appropriate instrumentation, apparatus, and materials (including ICT) to carry out investigative activities, experimental techniques and procedures with minimal assistance or prompting.

b. Carries out techniques or procedures methodically, in sequence and in combination, identifying practical issues and adjusting when necessary.

c. Identifies and controls significant quantitative variables where applicable, and plans approaches to take account of variables that cannot readily be controlled.

d. Selects appropriate equipment and measurement strategies to ensure suitably accurate results.

3. Safely uses a range of practical equipment and materials

a. Identifies hazards and assesses risks associated with these hazards, making safety adjustments as necessary, when carrying out experimental techniques and procedures in the lab or field.

b. Uses appropriate safety equipment and approaches to minimise risks with minimal prompting.

4. Makes and records observations

a. Makes accurate observations relevant to the experimental or investigative procedure.

b. Obtains accurate, precise, and sufficient data for experimental and investigative procedures and records this methodically using appropriate units and conventions.

5. Research, references, and reports

a. Uses appropriate software and/or tools to process data, carry out research and report findings.

b. Cites sources of information demonstrating that research has taken place, supporting planning and conclusions.

It is expected through time candidates will demonstrate these competencies consistently throughout subsequent practicals. It is not required that each competency be demonstrated in all practicals.

Candidates should complete and evidence at least 10 practicals across the 2-year course, it must be representative of entire content and therefore must include 1 assessed practical per unit topic.

Representative of the following skills:

Practical techniques to be completed by candidates

- Use appropriate apparatus to record a range of quantitative measurements (to include mass, time, volume, temperature, length, and pH)
- Use appropriate instrumentation to record quantitative measurements, such as a colorimeter or potometer
- Use laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions
- Use of light microscope at high power and low power, including use of a graticule
- Produce scientific drawing from observation with annotations
- Use qualitative reagents to identify biological molecules
- Separate biological compounds using thin layer/paper chromatography or electrophoresis
- Safely and ethically use organisms to measure:
  - plant or animal responses
  - physiological functions
- Use microbiological aseptic techniques, including the use of agar plates and broth
- Safely use instruments for dissection of an animal organ, or plant organ
- Use sampling techniques in fieldwork
- Use ICT such as computer modelling, or data logger to collect data, or use software to process data

A centre will need to demonstrate candidates have met these competencies, this will be done through regular moderation processes once every 2 years for quality assurance to ensure standards are maintained and assessed accurately.

This will require communication from a LRN moderator, evidence will need to be submitted to gain approval from the moderator to pass the centre and complete the endorsement process.

A video lesson may need to be recorded and submitted also additionally for international centres where visitation is not a viable option.

Additional guidance and training are available.

MATHEMATICAL REQUIREMENTS

Calculators may be used in all parts of the examination.

Candidates should be able to:

1. Complete equations involving addition, subtraction, multiplication, and division
2. Understand and use the symbols: =, <, <<, >>, >, ∝, ~.
3. Calculate percentages
4. Calculate percentage change
5. Translate information between graphical, numerical and algebraic forms
6. Manipulate a range of formula to identify the unknown variable.
7. Apply appropriate statistical tests to analyse and interpret data: Candidates t-test, Spearman's rank correlation, chi-squared test.
8. Understand and use standard deviation and ranges in data analysis
9. Deduce and determine uncertainties in measurements.
10. Carry out unit conversions
11. Solve algebraic equations using substitution and appropriate units.
12. Judge appropriate orders of magnitude and scale.
13. Use a calculator to find and use power, exponential and logarithmic functions.
14. Calculate circumferences, surface area and volume of a range of shapes circle, square, rectangle and triangle
15. Estimate values based on trends / sequences.
16. Calculate rate of change from graphs
17. Apply standard form to data
18. Able to sufficiently round data correctly
19. Provide answers to significant figures
20. Present values in line with equipment measurements e.g., 1.1cm^3 for a burette
21. Calculate energy efficiency
22. Calculate mean, mode and median
23. Calculate probability
24. Understand ratios.
25. Plot two variables from experimental or other data
26. Understand that y = mx + c represents a linear relationship
27. Determine the intercept of a graph

SAFETY IN THE LABORATORY

Candidates should be able to:

1. Identify relevant hazards and associated risks of equipment used
2. Identify relevant hazards and associated risks chemicals used
3. Carry out practical procedures carefully and thoroughly applying good practice
4. Individual core practical hazards and risks can be found at https://www.cleapss.org.uk/ (Members only)

The safety of candidates and staff are the responsibility of the centre involved, full guidance can be found on https://www.cleapss.org.uk/ (Members only).