NCCA
An Chomhairle Náisiúnta Curaclaim agus Measúnachta
National Council for Curriculum and Assessment

Draft Leaving Certificate Agricultural Science specification

For consultation

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Contents

Senior cycle

Senior cycle aims to educate the whole person and contribute to human flourishing. Students' experiences throughout senior cycle enrich their intellectual, social and personal development and their overall health and wellbeing. Senior cycle has 8 guiding principles.

Senior Cycle Guiding Principles	
Wellbeing and relationships	Choice and flexibility
Inclusive education and diversity	Continuity and transitions
Challenge, engagement and creativity	Participation and citizenship
Learning to learn, learning for life	Learning environments and partnerships

These principles are a touchstone for schools and other educational settings, as they design their senior cycle. Senior cycle consists of an optional Transition Year, followed by a two-year course of subjects and modules. Building on junior cycle, learning happens in schools, communities, educational settings, and other sites, where students' increasing independence is recognised. Relationships with teachers are established on a more mature footing and students take more responsibility for their learning.

Senior cycle provides a curriculum which challenges students to aim for the highest level of educational achievement, commensurate with their individual aptitudes and abilities. During senior cycle, students have opportunities to grapple with social, environmental, economic, and technological challenges and to deepen their understanding of human rights, social justice, equity, diversity and sustainability. Students are supported to make informed choices as they choose different pathways through senior cycle and every student has opportunities to experience the joy and satisfaction of reaching significant milestones in their education. Senior cycle should establish firm foundations for students to transition to further, adult and higher education, apprenticeships, traineeships and employment, and participate meaningfully in society, the economy and adult life.

The educational experience in senior cycle should be inclusive of every student, respond to their learning strengths and needs, and celebrate, value, and respect diversity. Students vary in their family and cultural backgrounds, languages, age, ethnic status, beliefs, gender, and sexual identity as well as their strengths, needs, interests, aptitudes and prior knowledge, skills, values and dispositions. Every student's identity should be celebrated, respected, and responded to throughout their time in senior cycle.

At a practical level, senior cycle is supported by enhanced professional development; the involvement of teachers, students, parents, school leaders and other stakeholders; resources; research; clear communication; policy coherence; and a shared vision of what senior cycle seeks to achieve for our young people as they prepare to embark on their adult lives. It is brought to life in schools and other educational settings through:

- effective curriculum planning, development, organisation, reflection and evaluation
- teaching and learning approaches that motivate students and enable them to improve
- a school culture that respects students and promotes a love of learning.

Rationale

Leaving Certificate science education provides a means by which students can investigate the natural world to foster an evidence-based understanding of how it works. Students learn that science, as a discipline, is a process that requires logic and creativity to construct scientific knowledge through the sharing of ideas and by developing, refining, and critically analysing these ideas. Students experience science as a personal and collaborative activity that is exciting, challenging and powerful in transforming the world in which we live.

Within the sciences, **Leaving Certificate Agricultural Science** is the study of the science and technology underpinning the principles and practices of agriculture. The agricultural sector is primarily focused on production of food and services in ways that are environmentally, economically, and socially sustainable. Leaving Certificate Agricultural Science takes a scientific approach to developing knowledge, skills, values and dispositions towards sustainable production and resource management, with a specific emphasis on evidence-informed decision making.

Students experience Leaving Certificate Agricultural Science through both practical and theoretical work. They gain hands-on experience in cultivating, growing, and managing resources, and connect this with agriculture theories and practices. They use a variety of tools, equipment and materials safely in laboratory and agricultural settings, as well as generating and analysing data to answer their questions. Students also consider the wider environmental, economic, and social systems in which agriculture functions, developing a scientific understanding of how agriculture interacts with these systems.

Agriculture is one of humanity's oldest and most influential activities, shaping societies, economies, and cultures. Students learn to appreciate the sustainable management of resources, drawing on practices developed by farmers and producers over time. They

consider agriculture as an evolving industry, shaped by policies, technologies and innovations. They also recognise agriculture's place in ensuring Ireland's food security; working with the environment and producing food in ways that positively responds to the challenges of climate change, biodiversity loss, rural development and sustainable productivity. Through this learning, Leaving Certificate Agricultural Science fosters care, legacy, and stewardship of the environment.

Aims

The aim of Leaving Certificate Agricultural Science is to provide students with an experience that develops their interest in and enthusiasm for the scientific and practical study of modern agriculture. In doing so, it aims to develop the knowledge, skills, values and dispositions necessary for students to become scientifically literate citizens who are well-prepared to engage with the agricultural sector, now and in the future.

More specifically, Leaving Certificate Agricultural Science aims to empower students to:

- build knowledge and understanding of a number of specified core concepts and fundamental principles of agricultural science
- develop the skills, values and dispositions needed to apply this knowledge to explain concepts, to analyse and solve problems, and make predictions in a variety of agricultural systems and interactions
- demonstrate inquiry and practical skills, in the context of scientific and agricultural practices
- consider different perspectives, systems or interactions that influence agriculture
- recognise the importance of stewardship of the environment in local, national and international contexts.

Continuity and progression

Leaving Certificate Agricultural Science provides continuity and progression, building on the knowledge, skills, values, and dispositions from students' early childhood education through to the junior cycle curriculum, and extends to wider experiences within the school and progresses beyond senior cycle.

Junior Cycle

Leaving Certificate Agricultural Science offers continuity and progression from junior cycle science. The learning at the core of junior cycle is described in the Statements of Learning, a number of which apply to scientific concepts, processes and practices, including problem-solving, design and communication skills, and to understanding and valuing the role and contribution of science and technology to society. Student learning in science is unified through the Nature of Science strand, which emphasises the development of a scientific habit of mind. There is an emphasis on inquiry in junior cycle science through which learners develop an understanding and appreciation of structures, processes and fundamental concepts that are essential to all science, as well as the ability to apply scientific principles to their everyday lives. Students also engage with agriculture-related topics such as plant and animal systems, sustainability, photosynthesis, respiration, genetic inheritance, and key physical measurements important for agriculture.

Many junior cycle subjects and short courses have close links with and support the learning in junior cycle science, particularly mathematics, geography, CSPE, SPHE, home economics and the technologies (T4) subjects. Across these subjects and short courses, students explore concepts such as land use, natural resources, the impact of human activities on the environment, food production, consumption, and health literacy.

Junior Cycle Science has close links with Leaving Certificate Agricultural Science in helping students to continue to develop their evidence-based understanding of the natural world; to develop their capacity to gather and evaluate evidence; to consolidate and deepen their skills of working scientifically; to make them more self-aware as learners and to become more competent and confident in their ability to use and apply science in their everyday lives. Students build on these scientific concepts, processes and practices as they progress through the two years of Leaving Certificate Agricultural Science.

Beyond senior cycle

Leaving Certificate Agricultural Science builds a solid foundation for students to progress to diverse futures, including participation in society, the worlds of work, further education and training, and higher education. The learning experienced while studying Agricultural Science can lead to many exciting and rewarding careers in the discipline and provides a foundation for a diverse range of opportunities in related areas, including agricultural, environmental, food, horticulture, animal health and welfare, human health, plant and animal science, business, media, sustainability, and biotechnology.

In addition, Agricultural Science incorporates a broad range of skills, including systems thinking, observation, classification, synthesis, digital skills, and evaluation of information. It teaches a range of generically useful competencies in areas such as communication, time management, organisation, and teamwork. These skills are relevant to all further study, and indeed all learning beyond formal education.

Agriculture holds an immediate and significant relevance for our daily lives. By studying Agricultural Science, students gain an appreciation of the role of agriculture in the complex ecology of the planet and of its sustainable development. They form critical thinking and reasoning skills, seeing the interconnectedness of agriculture with food and community, together with achieving a better understanding of their environment. They make responsible choices as confident, self-aware consumers of safe, secure, ethical, and sustainable food. This enables them to contribute within their own community, and beyond, as responsible citizens. They develop an appreciation of the social, cultural and economic perspectives informing our progress and our collective roles in striving towards food security and sustainable agriculture.

Student learning in senior cycle

Student learning in senior cycle consists of everything students learn **within** all of the subjects and modules they engage with **and** everything students learn which spans and overlaps **across** all of their senior cycle experiences. The overarching goal is for each student to emerge from senior cycle more enriched, more engaged and more competent as a human being than they were when they commenced senior cycle.

For clarity, the learning which spans **across** all of their senior cycle experiences is outlined under the heading 'key competencies'. The learning which occurs **within** a specific subject or module is outlined under the heading 'strands and learning outcomes'. However, it is vital to recognise that key competencies and subject or module learning are developed in an integrated way. By design, key competencies are integrated across the rationale, aims, learning outcomes and assessment sections of specifications. In practice, key competencies are developed by students in schools via the pedagogies teachers use and the environment they develop in their classrooms and within their school. Subjects can help students to develop their key competencies; and key competencies can enhance and enable deeper subject learning. When this integration occurs, students stand to benefit

- during and throughout their senior cycle
- as they transition to diverse futures in further, adult and higher education, apprenticeships, traineeships and employment, and

- in their adult lives as they establish and sustain relationships with a wide range of people in their lives and participate meaningfully in society.

When teachers and students make links between the teaching methods students are experiencing, the competencies they are developing and the ways in which these competencies can deepen their subject specific learning, students become more aware of the myriad ways in which their experiences across senior cycle are contributing towards their holistic development as human beings.

Key competencies

Key competencies is an umbrella term which refers to the knowledge, skills, values and dispositions students develop in an integrated way during senior cycle.

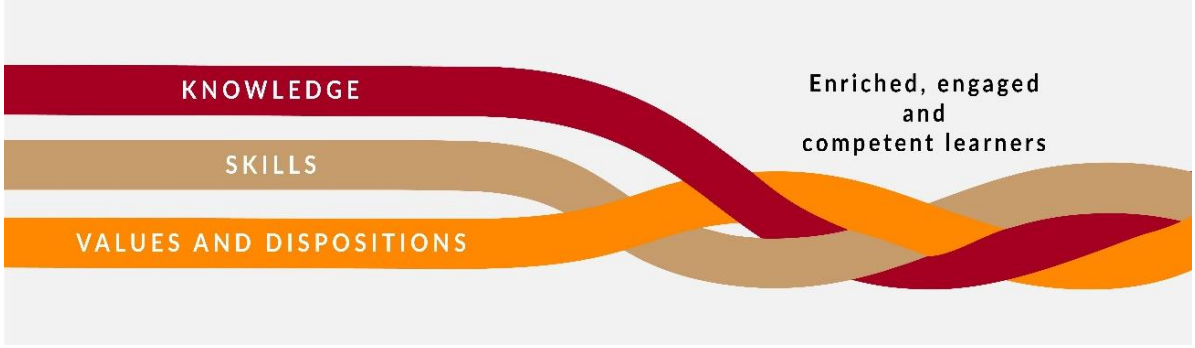

Figure 1 The components of key competencies and their desired impact

The knowledge which is specific to this subject is outlined below under 'strands of study and learning outcomes'. The epistemic knowledge which spans across subjects and modules is incorporated into the key competencies.

Figure 2 Key Competencies in Senior Cycle, supported by literacies and numeracy.

These competencies are linked and can be combined; can improve students' overall learning; can help students and teachers to make meaningful connections between and across different areas of learning; and are important across the curriculum.

The development of students' literacies and numeracy contributes to the development of competencies and vice-versa. Key competencies are supported when students' literacies and numeracy are well developed and they can make good use of various tools, including technologies, to support their learning.

The key competencies come to life through the learning experiences and pedagogies teachers choose and through students' responses to them. Students can and should be

helped to develop their key competencies irrespective of their past or present background, circumstances or experiences and should have many opportunities to make their key competencies visible. Further detail in relation to key competencies is available at https://ncca.ie/en/senior-cycle/senior-cycle-redevelopment/student-key-competencies/

The key competencies can be developed in Leaving Certificate Agricultural Science in a range of ways. For example, as students become curious about the natural world, they learn to express their curiosities in the form of scientific questions. They seek answers to these questions through the practices of investigation, trying out approaches in response to situations and **being creative** in their investigate methods. Through its focus on food security and responding to sustainability challenges, Agricultural Science invites students to imagine sustainable futures and consider steps to achieve these futures. Students of Agricultural Science develop a scientific habit of mind, drawing on a set of established scientific practices, in which **thinking and solving problems** is of great significance. They access, gather and process information from a variety of sources in both familiar and unfamiliar situations, and differentiate between fact and fiction. They do so with an open mind, underpinned by a natural curiosity about how the world works as they ask questions, gather and work with data, observe, and investigate scientific phenomena. As critical thinkers, Agricultural Science students need to continually examine their lines of argument, the evidence for their claims, and the motivations behind their beliefs.

Communicating scientific concepts and discoveries is an important aspect of the work of an agricultural scientist and supports knowledge transfer through the agrifood sector. As they prepare scientific communications, students develop an awareness of the need to present ideas in ways that are true to the claims being made but also appropriate to the intended audience. They observe, listen, remain open to different perspectives, and learn to figure things out for themselves. They frame scientific arguments by making claims and using logical reasoning informed by evidence, using relevant scientific language and terminology. They learn to question evidence and to seek clarity and understanding. Through their classroom experiences, students learn about **working with others**, as they co-operatively learn in pairs, groups and teams. They take on different roles, work together to achieve shared goals, give and respond to feedback from their teachers and peers, and interact safely and responsibly. At times, agricultural issues can be emotive for individuals or groups. Students learn to effectively navigate the emotional and social aspects of these issues as they listen to and appreciate other viewpoints, remain open to different perspectives, and manage challenges as they arise. These behaviours increase students' sense of self-efficacy as they become

flexible, adaptable and willing to learn from mistakes. These attributes positively contribute to **managing learning and self**. Students make informed choices, and, with appropriate support, take responsibility for their educational journey and the various career paths that agriculture may offer them.

Agricultural Science provides an opportunity for students to critique, challenge, protect, and/or consider how to transform the systems that agriculture is connected to and influences. This leads to the creation of knowledge for sustainable production and resource management. Through becoming agricultural scientists, students are **participating in society**, contributing to a sustainable world in their schools, communities, wider society, and through their own personal behaviours and choices. They learn to reflect on their role in relation to challenges in the agricultural sector and, where necessary, challenge their own values and the values of others in relation to complex issues. In their study of Agricultural Science, students may face difficulties in their engagement with primary and secondary data. Whilst there is a progression and structure to scientific investigation, it is not a linear process, and sometimes unexpected results and errors may occur. As students work through these difficulties, they build their individual and group resilience as investigators, assessing and responding to risks and errors in healthy ways. This helps in **cultivating wellbeing**, as they learn to support and help each other. They further cultivate wellbeing through applying their knowledge of Agricultural Science to being safe on farms, in laboratories and other agriscience settings, in living healthy personal lives, and in their care for the living world through their career pursuits and everyday lifestyle choices.

Literacies and numeracy support the development of key competencies in the Leaving Certificate Agricultural Science classroom, and vice-versa. Literacy concerns students' ability to use and put words together to explain their understanding of concepts through a variety of means, including written, reading, spoken, and digital. Numeracy is particularly relevant where students gather, interpret, and critically evaluate primary data, using a variety of analogue and digital means. They engage in scientific inquiry and develop data-driven representations to explain these phenomena, as they draw on and develop their various competencies in subject specific and cross-disciplinary ways. This enhances their scientific literacy. As they make connections between scientific phenomena, broader agricultural principles and local understanding, students further develop a local and regional literacy of agricultural science.

Strands of study and learning outcomes

This Leaving Certificate Agricultural Science specification is designed for a minimum of 180 hours of class contact time.

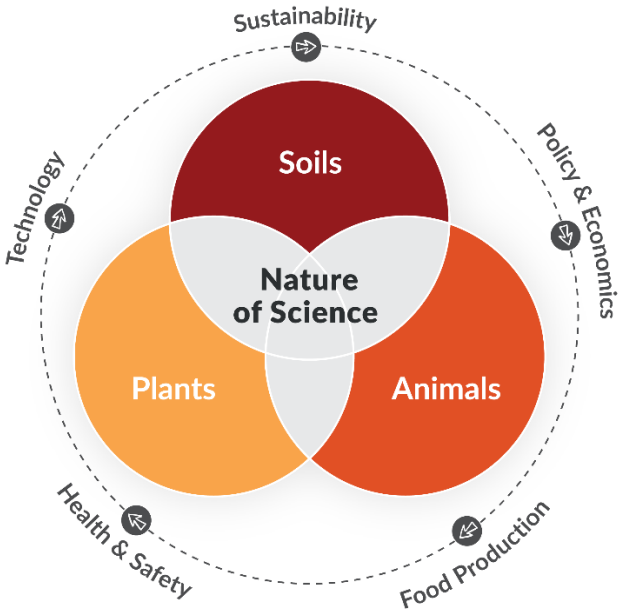

Fig. 1 – structure overview

The unifying strand, Nature of Science, reflects continuity and progression from Junior Cycle Science and involves students applying the principles and practices of science to their agricultural science learning in the three contextual strands. The learning outcomes in the unifying strand identify the knowledge, skills, values and dispositions related to scientific practices which are essential to students' learning *about* science throughout the course, underpinning the activities and content in the other strands. The learning outcomes in the other three contextual strands— Soils, Plants, and Animals—identify the knowledge *of* agricultural science which includes its core concepts, models and theories that explain and predict agricultural phenomena. The specification emphasises a non-linear, integrated approach to learning throughout these strands.

The specification identifies five crosscutting themes – Sustainability, Health & Safety, Policy & Economics, Technology, and Food Production. These themes, illustrated as surrounding the contextual strands, permeate and provide contexts for the study of these strands. They act as lenses through which students explore the application of knowledge *from* agricultural science. Through these lenses, students engage with contemporary issues in agricultural science as they pose questions and integrate and apply their learning from across the specification.

An overview of each strand is provided below, followed by a table. The right-hand column contains learning outcomes which describe the knowledge, skills, values and dispositions students should be able to demonstrate after a period of learning. The left-hand column outlines specific areas that students learn about. Taken together, these provide clarity and coherence with the other sections of the specification.

Learning outcomes should be achievable relative to students' individual aptitudes and abilities. Learning outcomes promote teaching and learning processes that develop students' knowledge, skills, values and dispositions incrementally, enabling them to apply their key competencies to different situations as they progress. Students studying at both Ordinary level and Higher level will critically engage with Agricultural Science, but the context, information and results arising from that engagement will be different.

Ordinary level	Higher level
Students engage with a broad range of knowledge, mainly concrete in nature, but with some elements of abstraction or theory. Students demonstrate and use a moderate range of cognitive skills and tools to use information, plan and develop investigative strategies and select from a range of procedures and apply known solutions to a variety of problems. They identify and apply skills and knowledge in both familiar and unfamiliar contexts. Students develop scientific literacy skills and use evidence and data to communicate findings and draw conclusions to questions posed by themselves and others.	Students engage with a broad range of knowledge, including theoretical concepts and abstract thinking with significant depth in some areas. Students demonstrate and use a broad range of specialised skills to evaluate, and use information, to plan and develop investigative strategies, and to determine solutions to varied problems. They identify and apply skills and knowledge in a wide variety of both familiar and unfamiliar contexts. Students develop, demonstrate and use scientific literacy skills and use appropriate evidence and data to effectively communicate findings and draw valid conclusions to questions posed by themselves and others.

Table 1: Design of learning outcomes for ordinary and higher level

Unifying Strand: Nature of Science

This strand builds on the unifying strand from Junior Cycle Science and continues to bring to life the practices and norms underpinning the facts, concepts, laws, and theories of science. Building on existing knowledge, students develop an appreciation of science as a process; a way of knowing and doing and an understanding that the discipline of science includes understanding the nature of scientific knowledge as well as how this knowledge is generated, established and communicated. In senior cycle it is expected that students will be able to meet these learning outcomes with a greater degree of independence.

As they learn to work like scientists, they develop a habit of mind that sees them rely on a set of established procedures and practices associated with scientific inquiry to gather evidence, generate models[1] and test their ideas on how the natural world works. It becomes apparent that the process of science is often complex and iterative, following many different paths. Students will learn to obtain and evaluate primary data (i.e., collected by themselves) and secondary data (data collected by somebody else).

Students develop an understanding that whilst science is powerful, generating knowledge that forms the basis for many advances and innovations in society, it has limitations. The application of scientific knowledge to problem-solving can be influenced by considerations such as economic, social, environmental, and ethical factors.

Unifying Strand Learning Outcomes

Students learn about…	Students should be able to…
U1 Scientific knowledge • the nature of scientific knowledge • science as a global enterprise that relies on clear communication, international conventions, peer review and reproducibility • recognising bias	1. appreciate how scientists work and how scientific ideas are modified over time 2. conduct research relevant to a scientific issue, evaluate different sources of information including secondary data, understanding that a source may lack detail or show bias

[1] Representations of ideas, structures, processes, or systems through a variety of means such as words, diagrams, equations, physical models or simulations

Students learn about…	Students should be able to…
U2 Investigating and Communication in Science	
• questioning and predicting	1. recognise questions that are appropriate for scientific investigation 2. pose testable hypotheses developed using scientific theories, and explanations and evaluate and compare strategies for investigating hypotheses
• objectivity ○ identifying potential sources of random and systematic error ○ evaluating data in terms of repeatability and reproducibility	3. design, plan and conduct investigations; explain how reliability, accuracy, precision, error, fairness, safety, integrity, and the selection of suitable equipment have been considered 4. produce and select data (qualitatively/quantitatively), critically analyse data to identify patterns and relationships, identify anomalous observations, draw and justify conclusions 5. review and reflect on the skills and thinking used in carrying out investigations, and apply their learning and skills to solving problems in unfamiliar contexts
• communicating results and perspectives to a range of audiences	6. organise and communicate their research and investigative findings in a variety of ways fit for purpose and audience, using relevant scientific terminology and representations
U3 Science in society	
• evaluating evidence for relevance, accuracy, bias	1. evaluate media-based arguments concerning science and technology
• relating science and scientists to society by considering economic, social, environmental, and ethical factors	2. research and present information on the contribution that scientists make to scientific discovery and invention, and evaluate its impact on society

Students learn about…	Students should be able to…
U4 Making connections • generating and using models • the evolving nature of models • the limitations of models	1. appreciate that models • are simplified representations of systems or observable events with underlying assumptions • can be modified as more data becomes available • attempt to predict the behaviour of a system/observable event
• systems • connections between agricultural contexts • making connections between local and global contexts	2. explain interconnections between policy, economics, society, environment, and agricultural practices
• differentiating between different systems, processes, and concepts in agriculture	3. describe how different enterprises and production systems influence each other
• health and safety hazards including vehicles and machinery, chemicals and livestock	4. appreciate the need for controls and precautions to prevent accidents, injury and ill health, and to promote the welfare of animals and humans
• controls and precautions including biosecurity measures, risk assessment for all farm activities, emergency procedures and protocols, systems for safe working practices including signs, adhering to health and safety guidance and best practices, responsible behaviour in farm environments	
	5. appreciate that agricultural decisions are informed by scientific data

Strand 1: Soils

In this strand, students learn about soil as a natural resource, the foundation of our food system, and a medium for the growth of plants, as well as a habitat in its own right. Through engagement with the learning outcomes, they will develop an understanding of the role and function of soil and be empowered to appreciate its importance in providing for the growth of grass, crops, and animals. As they integrate their learning with the other strands, they evaluate the ecosystem services provided by soils and explore future possibilities for improving those services.

As they investigate, model, and understand soil functions, composition and formation, students will develop an evidence-informed understanding of the soils around them and across Ireland and relate the processes and properties of these soils to their potential uses. They learn to recognise soil formation as an ongoing process; one that has happened, is happening and continues to do so.

As they explore first-hand agricultural practices to enhance soil functions in a range of settings, students appreciate that good soil management has far reaching benefits beyond agricultural enterprise. They are encouraged to adopt a critical stance on the various practices and systems of agriculture that can influence soil quality, enhance production, and promote sustainability.

Strand 1 learning outcomes

Students learn about…	Students should be able to…
1.1 Soil functions, composition and formation	
• soil as a medium for plant growth, a habitat, a means of water storage, purification and supply, and storage of carbon	1. outline the functions of soil
• visual examination of soils including soil aggregates, and separation of particles as investigative techniques	2. investigate soil composition, use primary and secondary data to support conclusions
• composition of soil as aggregates of weathered rocks, organic material including living organisms, water, soil air	
• rocks (granite, limestone, basalt, sandstone)	3. relate the influence of parent material to soil properties

Students learn about…	Students should be able to…
• soil properties including pH, texture, drainage, aeration, temperature, mineral particle content • factors and processes including parent material, weathering processes – physical, biological, chemical (detailed chemical description not required), accumulation and leaching, time, topography, climate	4. model the formation of soil
1.2 Soil texture and profiles • sandy, clay, and loam textures • using a soil textural triangle	1. investigate the texture of topsoil by feel and sieve method, use primary and secondary data to support conclusions 2. distinguish between soil textural classes and soil types 3. investigate the influence of soil texture and degree of compaction in soils on capillarity and infiltration rate, use primary and secondary data to support conclusions
• the concept of soil horizons including O,A,B,C horizons • leaching - movement of nutrients, particles and organic matter through the soil, including acid leaching • leaching and compaction occurring in horizons • gleying - formation due to poor drainage and where waterlogged conditions prevail (detailed description of chemical processes not required)	4. relate the processes of leaching and gleying to the formation of soil horizons
• soil types and associated land use potentials including brown earths (arable farming and pasture), podzols (grazing and forestry), gleys (pasture), peats (rough grazing, carbon sequestration through rewetting)	5. identify soil types in Ireland and their soil profiles; relate the properties of soils to their land use potentials

Students learn about…	Students should be able to…
1.3 Soil properties	
• physical properties including structure, texture (sandy, clay, loam) with reference to particle sizes, porosity, drainage	1. relate the physical properties of soils to one another in different soil textural types with reference to temperature, water, and air content
• macronutrients (including N, P, K, Ca, Mg, S), and micronutrients (such as Fe, Mn, Cu, B) and their roles in preventing deficiency diseases in plants and animals • liming in raising pH and promoting flocculation • pH in promoting availability of nutrients, sustaining growth of different plants and optimising presence of organisms including earthworms and microorganisms • cation exchange – exchange of cations held on clay and organic matter particles in soil (detailed chemical description not required) • cation exchange capacity - the measure of particles to adsorb exchangeable cations available to plants and resist leaching	2. explore the role of plant-available nutrients, pH and liming, and cation exchange in the functioning of soils
	3. measure soil pH; recognise that pH is related to nutrient availability
• clays having a negative charge allowing them to attract cations and to bind together, presence of clays and organic matter as the primary causes of flocculation in soil aggregates, soils with high clay and organic matter content forming more stable aggregates due to flocculation	4. model flocculation in soil

Students learn about…	Students should be able to…
• texture, presence or absence of lime	5. investigate factors affecting flocculation in soils, use primary and secondary data to support conclusions
• organic matter in soils and their functions including humus (improves soil fertility, stores nutrients, increases water retention, maintains soil structure), microbial biomass (decomposition, cycling of nutrients, formation of stable organic matter), plant and animal residues (adds nutrients and organic matter, supports the food web of soil organisms), living organisms (improve soil structure, support the food web of soil organisms, increase soil biodiversity)	6. distinguish between the types of organic matter in soils and their importance 7. measure the percentage organic matter and calculate organic carbon in soils
• the carbon cycle – including photosynthesis, respiration, decomposers, fossil fuels and carbon sinks • the nitrogen cycle – including nitrogen fixation, nitrification, decomposition, nitrification	8. model biogeochemical cycles in soils, including the carbon and nitrogen cycles (names of microorganisms not required)
• aeration and drainage, mixing layers	9. investigate the activity of earthworms in a soil, use primary data to support conclusions 10. calculate an estimate for the number of earthworms in a pasture using primary data

Students learn about…	Students should be able to…
• the concept of a microbiome • the concept of the rhizosphere • the role of mycorrhizal symbioses between plants and fungi in promoting soil structure, water availability, nutrient cycling, biodiversity, and ecosystem sustainability • symbiotic bacteria in the root nodules of clover	11. explore soil microbiomes and the relationship between soil microorganisms and roots 12. investigate the presence of microorganisms in soils, use primary data to support conclusions
• the positive improvements including soil structure, water holding capacity, porosity	13. research the impact of increasing organic matter content on soil properties in conventional and organic farming, use secondary sources to support conclusions

1.4 Soil management practices
• how good soil management increases synergies and reduces trade-offs
• how improving one aspect of soil function can lead to reduction of function in others (trade-offs), including tillage operations (improve seedbeds but can damage soil structure over time), adding fertiliser (improves nutrient levels and production but can increase potential for run off)
• synergies including
  ○ improved nutrient cycling leading to improvements in carbon content, soil nutrients and productivity
  ○ increased organic matter content leading to improvements in soil structure, water holding
	1. discuss trade-offs and synergies resulting from soil management and functions

Students learn about…	Students should be able to…
○ capacity and soil nutrient content availability ○ planting cover crops improves soil structure, increases biodiversity and organic matter content, and reduces run-off • soil degradation	2. identify threats to soil quality including compaction, poaching, erosion, acidification, nutrient loss, and contamination
1.5 Agricultural engagement • data including soil pH, available P and K, soil index	1. analyse the results of a soil analysis report for a farm; justify agricultural decisions made on the farm based on the results of the report
• using data to inform practices including fertiliser types and levels, crop choices, soil management practices	
• run off, zoonotic diseases, pesticides and fertilisers, toxic gases from decomposition of slurry and manure, risk of injury through use of machinery	2. identify health and safety hazards associated with soil management on a farm and outline necessary controls to prevent accidents, injury and ill health
• controls including good soil management to promote health and safety, systems for safe movement of animals and humans	
• visual identification of soil degradation	3. apply knowledge of soil degradation to recommend improvements to an area of land
• sustaining or improving land	

Strand 2: Plants

In this strand, students learn about the role and importance of a variety of plants, including weeds, grasses, crops as forage and crops for human consumption. Through engagement with the learning outcomes, they will gain an understanding of aspects of the physiology of a wide variety of plants and use this knowledge for identification purposes. As they learn about the principles of crop production, they are provided with opportunities to integrate their learning with the other strands and root their understanding in experiences of agricultural settings.

As they investigate, model, and understand a wide variety of factors that influence the production and management of crops and grassland students develop an evidenced-informed understanding of farming practices around them and across Ireland.

As they further explore agricultural practices that look to enhance sustainability students consider evidence that outlines innovative approaches being used to realise sustainable crop and grassland production. In this way students are empowered to better understand the role of innovation in meeting the challenges of food security, climate change, biodiversity, and sustainable livelihoods through efficient and sustainable agricultural production.

Strand 2 learning outcomes

Students learn about…	Students should be able to…
2.1 Plant physiology and identification • root, stem, leaf and flower • functions including nutrient absorption, movement, anchorage, storage, nutrient utilisation, pollination (insect and wind) resulting in seed production • osmosis and transpiration resulting in transfer of water and dissolved nutrients • photosynthesis resulting in production of glucose in plants and production of biomass/yield • respiration resulting in energy transfer for cellular activities	1. relate the main structures and processes of a flowering plant to relevant functions for crop production

Students learn about…	Students should be able to…
• identification tools and images of leaves and/or inflorescence • grasses, cultivated crops, and weeds including perennial ryegrass, Italian ryegrass, red clover, white clover, timothy, plantain, docks, daisy, thistles, ragwort, wild oat, nettle, wheat, barley, oats, maize, peas, potatoes, rapeseed, chicory, kale, beans • annual, perennial and biennial life cycles • crop and weed identification leading to sustainable management • mixed/muti-species vs monocrop grazing • impact of plants in promoting biodiversity and contributing to ecosystem services • species including giant hogweed, rhododendron, Japanese knotweed	2. identify plants in Irish agricultural systems and outline their role in different land management practices 3. research using secondary sources the impact of invasive plant species in Ireland on plant growth and biodiversity and measures to reduce their impact
2.2 Land use and crop production • human and animal consumption • soil management including cover crops • tractors, ploughs, harrows, rollers, cultivators, seed drills, fertiliser spreaders, sprayers, slurry spreaders, harvesters, mowers, balers and wrappers, hay turners, toppers, silage trailers	1. outline the function of Irish agricultural crops 2. identify machinery associated with crop production and management

Students learn about…	Students should be able to…
• soil– root and shoot support, conducive conditions for germination, water and air for growing crops, cycling of nutrients • seed selection (certified vs uncertified)– genetic potential of seeds influences yields, disease and pest resistance, tolerance to environmental stresses, seed purity and germination rates, suitability to local conditions • seedbed preparation and sowing – optimise germination and survival rate, support root development, anchoring and crop establishment, reduce weed and pest competition, promote uniform crop growth through even seed planting depth and spacing	3. relate the influences of soil, seed selection, seedbed preparation and sowing to the productivity of a crop
• measures including ranges in plant height, germination rate (%), crop health, visual inspection	4. investigate and compare plant uniformity for different seed varieties of the same agricultural plant, use primary and secondary data to support conclusions 5. investigate the effect of nutrients on the growth of an agricultural plant species and measure its yield, use primary data to support conclusions
• integrated pest management, including diseases, as a preventative approach encompassing soil management, mechanical controls, crop rotation, sowing resistant varieties, including certified seed, biological controls, chemicals • crop rotation as a means of improving soil structure, organic matter content and nutrient levels, indirect disease and pest control • crop rotation systems including cover crops	6. illustrate strategies for crop protection against weeds, diseases and pests

Students learn about…	Students should be able to…
• growth stages of barley including germination and emergence, tillering, stem elongation, ear emergence, ripening • growth stages of potatoes including sprouting and emergence, vegetative growth, tuber formation and swelling, maturation • seedbed cultivation, time of sowing, varieties (including certified seed), fertiliser requirements, integrated pest management (including diseases), establishment, harvesting processes, yield and quality, storage, rotation of the crop • precision agriculture (GPS, sensors, drones, satellite imagery, etc.) • automation and robotics for planting, weeding, and harvesting • genetic enhancement of crop varieties against pests and diseases and improving yield quality using heritage crops, traditional biotechnology and more recent technologies such as genome editing	7. model the growth of • barley • potatoes 8. apply knowledge of the growth of barley (including winter and spring varieties) and potatoes to describe their husbandry throughout the season and quality measurement 9. distinguish between the practices of crop production in organic and conventional agricultural systems 10. research the role of innovation in crop production to address food security and sustainability using evidence from secondary sources
2.3 Grassland management • germination, establishment, tillering, vegetative growth, reproductive stage (pollination) • approaches to maximise production from grass-based systems including seed selection (mixed vs single variety), heading dates pre-grazing	1. investigate the botanical composition of two contrasting areas of grassland, use primary data to support conclusions 2. model the growth of a grass plant 3. apply knowledge of grass growth to explain grazing management considerations throughout the season

Students learn about…	Students should be able to…
yields (kg DM/ha), grazing systems including rotational grazing, matching stocking rates to grass growth, typical annual grass growth curve (kg DM/ha/day), fertiliser, pasture measurement and management	
• closing fields, fertiliser, mowing at leafy stage, wilting to appropriate DM and moisture content, harvesting and chopping, filling and compacting (pits and bales), sealing (pits and bales) and fermentation process, additives	4. apply knowledge of grass growth to describe the steps of silage production
• visual assessment (colour, smell, dry matter content), laboratory analysis (pH, %DM), leaf to stem ratio • factors including moisture content, degree of compaction, anaerobic conditions	5. investigate factors that influence the quality of silage, use primary and secondary data to support conclusions
• nitrogen fixation, increased herbage quality, enhanced DM intake, improved soil structure and fertility, improved biodiversity, reduced weeds, increased protein	6. consider the benefits of sowing red and white clover in grass swards
• grazed grass, silage (pit and baled), concentrates, fodder crops	7. compare the feed and monetary value of grass with other animal food sources
• using a refractometer • factors including time of year, time of day, grass variety	8. investigate factors that influence the sugar content of grass, use primary and secondary data to support conclusions
• reseeding practices (including direct sowing and stitching in) and choice of seed mixtures, fertiliser, nutrient management, use of grass measurement data on kg DM/ha to inform systems of rotation and decisions on closing off paddocks, maximising forage quality through timing of silage cutting and removing surplus grass when grass growth	9. identify steps farmers can take to ensure high grass quality and utilisation

Students learn about…	Students should be able to…
exceeds demand, technologies to support grass management • mowing from inside to out, field margins, multi-species swards, hedgerows	10. research approaches farmers can take to support biodiversity through crop and grassland management practices using evidence from secondary sources
2.4 Agricultural engagement • growing plants from seed to maturity in local settings (e.g. school grounds, polytunnel, garden, local farm) • quality measurements of crops such as yield, visual inspection, DM content, % moisture, thousand grain weight, grain hardness and density, tuber size and uniformity, density, post-harvest quality • farm features including size, geographical location (elevation, topography), production system in place, soil type, plant varieties, machinery, storage facilities, health and safety practices, seasonal practices, any unique features of the farm such as technology, breeding, economics, recent adaptations to influencing factors (market, climate change, etc.) • health and safety hazards including vehicles and machinery, chemicals, pesticides, herbicides, fungicides, fertilisers, water hazards, noxious weeds, dust and particle inhalation, silage pits, bale stacks height, grain and crop storage • controls including appropriate PPE, ventilation, secure storage, handling, and disposal of chemicals, well-maintained machinery and correct safety practices, PTO guards, awareness of farm layout, clear workspaces, signage, safe work practices, risk assessments	1. apply knowledge of husbandry to grow a chosen food crop and conduct a quality measurement of the crop 2. explore the system of crop or grassland management on a farm 3. identify farm health and safety hazards associated with the management of crops or grassland on a farm, and outline the controls necessary to prevent accidents, injury and ill health

Students learn about…	Students should be able to…
• sources of evidence to inform decisions such as numerical data, observations, local experience	4. justify, based on evidence, grassland management decisions on a farm

Strand 3: Animals

In this specification, the study of animals includes the traditional farm animals of cattle, sheep, and pigs. The focus of learning in this strand is the interconnected nature of aspects of animal production across various systems. From feeding to housing, husbandry, breed selection, and disease prevention – students learn to appreciate how these interconnected areas all contribute to maximising the welfare of animals, which in turn maximises production and profits for farmers and the agricultural sector. Through engagement with agriculture in diverse settings, students gain insight into the practical application of the science of animal production in a variety of systems. They recognise that advancements in technology, including genetic technologies, can be transformative in how animal production advances as a sustainable and profitable industry.

Strand 3 Learning outcomes

Students learn about…	Students should be able to…
3.1 Animal enterprises and systems • dairy - liquid milk and creamery milk production • beef –suckler to beef, dairy calf to beef • sheep – lowland and hill, early and mid-season lambing • pigs – intensive indoor production, outdoor production • conventional and organic farming	1. outline the function of Irish livestock systems and enterprises within each system
breeds and crossbreeds including • cattle - Friesian, Holstein, Jersey, Montbéliarde, Hereford, Angus, Charolais, Simmental, Belgian Blue, Limousin, Kerry, Irish Moiled, Dexter • sheep - Texel, Belclare, Suffolk, Charollais, Blackface Mountain, Cheviot, Bluefaced Leicester, Border Leicester, Galway • pigs – Large White, Landrace, Duroc, Tamworth, Saddleback, Oxford	2. identify the characteristics of breeds and crosses of cattle, sheep, and pigs which make them identifiable and suitable to specific enterprises

Students learn about…	Students should be able to…
• characteristics including coat colour and patterns, breed shape and conformation as linked to use in enterprises • factors including type of livestock, stocking rates, management of costs, market prices and exports • government supports and subsidies • performance testing, physical traits, progeny testing, genotyping and genomic selection	3. evaluate secondary sources on the profitability and return on investment for different animal enterprises 4. outline the principles of genetic improvement in production systems
3.2 Animal physiology • dental formulae • monogastric and ruminant digestive systems • structure and functions of digestive organs including mouth, oesophagus, stomach, pancreas, liver, small intestine, large intestine, rectum, anus, rumen, reticulum, omasum, abomasum • role of symbiotic microorganisms in digesting cellulose, producing vitamins, amino acids, and methane in ruminant animals • unique features of digestion in a calf including pre-ruminant, abomasum dominant, suckling to develop oesophageal groove, increase of coarse feed for scratch factor • female reproductive system including ovaries, fallopian tubes, uterus, cervix, vagina, vulva • male reproductive system including testes, epididymis, vas deferens, urethra	1. model the digestion of food in cattle, sheep, and pigs 2. compare digestion from a young to mature ruminant 3. describe the structure and function of the reproductive systems of cattle, sheep, and pigs

Students learn about…	Students should be able to…
• features including oestrous cycles (polyoestrous vs seasonally polyoestrous) and length, duration of oestrous, gestation length • roles of hormones including FSH, LH, oestrogen, progesterone, testosterone • structure and function of the udder including external (arrangement of quarters, teats and supporting ligaments), internal (alveoli, milk ducts and cisterns, teat canal) • role of the alveoli, ducts and teats in milk production and secretion • milk let-down as a result of stimulus and oxytocin release • impact of adrenaline on milk let-down • natural suckling and mechanical milking systems • lactation curve	4. describe the general breeding cycle for a cow, ewe, and sow 5. model the milking process in cows
3.3 Animal nutrition and health • carbohydrates, fats, proteins • minerals including calcium, phosphorous, magnesium, cobalt, iron, copper, iodine, zinc, selenium • vitamins including fat soluble (A,D,E,K) and water soluble (C,B) • bulky feeds including grass, silage, hay, straw, haylage • concentrate feeds including cereals, milling by-products, oilseed meals, molasses, protein supplements, vitamins and minerals	1. apply knowledge of a balanced diet and nutrient types to distinguish between bulky feeds and concentrates

Students learn about…	Students should be able to…
• grass-based feeding, grazing systems, supplementation, total mixed ration (TMR) • feed quality and nutritive value – crude protein, fibre content, dry matter (DM) and dry matter digestibility (DMD), animal needs and feed demand, cost of grass vs concentrate rations, maintenance vs production diet, body condition score of the animal, FCR, housing environment	2. describe the factors informing indoor and outdoor feeding for cattle and sheep
• mastitis, internal parasites (lungworm, stomach worm, liver fluke), external parasites (lice, ticks, maggots), bloat, acidosis, pneumonia, lameness (including foot rot and joint-ill), scour (nutritional and bacterial), tetany, milk fever, red water fever • aspects including disease prevention through dosing and vaccination, reducing external pathogens entering the farm, waste management, hygiene and sanitation, technology	3. outline common health issues occurring in farm animals including their causes, symptoms, prevention and treatment
• quarantine and isolation, traceability, interventions when outbreaks occur such as antibiotics, technology	4. discuss the importance of biosecurity in preventing the introduction and spread of disease, and promoting animal health and food security on farms
• tuberculosis, bovine viral diarrhoea, brucellosis, sheep scab, blue tongue, foot and mouth disease, African swine fever, BSE • public health interest, risk of zoonoses, animal health and welfare, economic stability, trade, and legal requirements	5. appreciate the need for compliance in relation to notifiable diseases of cattle, sheep, and pigs

Students learn about…	Students should be able to…
3.4 Cattle	
• calving, weaning, rearing, lactation finishing	1. describe the management of cattle, including the dietary requirements at different growth/development stages
• use of forage, concentrates, TMR, grassland management, housing and handling (dosing, dehorning, castration), health and welfare practices, record keeping, tagging and traceability	
• indicators including milk yield, milk solids, reproductive efficiency, carcass weight and conformation (EUROP scale, fat score), age at slaughter, calving interval, replacement rate, mortality rate	2. identify how breed, nutrition, housing, disease prevention, hygiene influence performance indicators and outputs from beef and dairy enterprises
• calculating and interpreting DLWG	3. apply knowledge of daily live-weight gain (DLWG) to secondary data sources for a beef animal
• ideal body condition score at different stages of growth and production for beef and dairy	4. apply knowledge of management and nutrition to alter body condition score of a herd using secondary data
• changing environment and feeding regime	
• attributes including nutritional values, including higher beta-carotene, flavour, appearance, and texture, sustainability and animal welfare, traceability and quality, market significance	5. discuss the attributes of Irish grass-fed milk and beef
• milk composition	
	6. investigate how storage influences the presence of bacteria in milk
	7. research factors influencing the presence of microorganisms in milk
• evaporation test of milk	8. investigate the percentage of water and solids in two different milk samples, use primary data to support conclusions

Students learn about…	Students should be able to…
• indicators of milk quality which impact price including somatic cell count, total bacterial count, milk composition	9. discuss factors influencing the presence of microorganisms in milk and the impact of milk quality on milk price
	10. discuss the role of emerging technologies in cattle production, including advantages and disadvantages
• practices including selective breeding (including cross breeding of dairy dams to beef sires), identifying oestrous, the role and use of artificial insemination compared to stock bulls, sexed semen, embryo transfer, economic breeding index (EBI), Euro-Star	11. outline the practices and benefits of breeding management in the context of beef and dairy production
• benefits including increased milk or meat production, improved carcass quality, enhanced disease resistance, hybrid vigour, increased genetic merit of the herd, improved sustainability through increased animal efficiency	
3.5 Sheep	
• lambing, weaning, rearing, finishing	1. describe the management of sheep, including the dietary requirements at different growth/development stages
• creep feeding lambs/store lambs, nutrition of ewes carrying singles, twins, triplets, grassland management, mating	
• maintenance and production diets, flushing, steaming up	
• housing and handling, health and welfare practices (including docking, dagging, shearing, management of lameness and hoof care, dipping, dosing, scanning, fostering), ageing ewes through dental formulae, vaccination, record keeping, tagging and monitoring	

Students learn about…	Students should be able to…
• carcass weight, lambing rate, days to slaughter, kill out percentage, mortality rate, body condition score • outputs including meat, wool, dairy • practices including genotyped rams and star rating, maternal, ram and ewe selection, terminal and replacement sires, ram and raddle, synchronised lambing, crossbreeding • increased lamb production, increased prolificacy, hybrid vigour	2. identify performance indicators and outputs in sheep production 3. distinguish between lowland and hill sheep production 4. explore breeding practices for early and mid-season lambing and their benefits in sheep production 5. apply knowledge of the breeding programme to determine ram : ewe ratio
3.6 Pigs • farrowing, weaning, finishing • management including housing requirements, lactation and gestation diets for sows, FCR, phase feeding based on weight and stage, biosecurity, disease and temperature control, enrichment materials and welfare • artificial insemination, inducing oestrous through presence of boar • benefits including increased prolificacy, improved litter sizes and weight, reduced inbreeding, increased FCR, hybrid vigour • carcass weight, litter size, kill out percentage, food conversion ratio (FCR), body condition score, mortality rate	1. describe the management of pigs, including the dietary and housing requirements at different growth/development stages 2. explore breeding practices and their benefits in pig production 3. identify performance indicators in pig production 4. compare outdoor and indoor pig production in terms of biosecurity requirements, waste management, output, and animal welfare

Students learn about…	Students should be able to…
3.7 Agricultural engagement	
• features including animal breeds and production system in place, seasonal practices, any unique features of the farm such as technology, breeding, economics, recent adaptations to influencing factors (market, climate change, etc.), engagement with relevant schemes	1. explore the system of animal production on a farm
• management practices for handling and housing farm animals, optimal animal health and welfare, animal manures – slurry, farmyard manure (FYM), delivering socially, economically and environmentally sustainable systems, ensuring quality, safe and traceable food for the consumer, animal feeding	
• chemicals including antibiotic residues, medicines, dips, risk of injury through handling animals, machinery accidents, biosecurity risks through contact (direct, indirect) with animals, zoonotic diseases, ventilation risk – toxic gas inhalation through agitation of slurry/FYM	2. identify the potential hazards (physical, biological, health) associated with working with farm animals, and safe work practices/controls
• practices including good farm management to promote health and safety, systems for safe movement of animals and humans, risk assessment, appropriate protection when working with animals (animal handling facilities and housing, PPE), safe storage and handling of animal manures (slurry, FYM), storage of chemicals and medicines, good hygiene practices and systems	

Teaching for student learning

Senior cycle students are encouraged to develop the knowledge, skills, values and dispositions that will enable them to become more independent in their learning and to develop a lifelong commitment to improving their learning.

Leaving Certificate Agricultural Science supports the use of a range of effective teaching and learning approaches that respond to the strengths, needs and interests of all students. The course is student-centred in its design and emphasises a practical experience of agriculture. Through tasks that connect scientific concepts with practical learning, students engage with Agricultural Science as a living, relatable science that holds practical meaning for their lives. They gradually and progressively develop skills that can be brought from one activity to the next, building their capacity to work like a scientist. They learn through practical experiences such as cultivating and growing, communicating, modelling, investigating, and developing their critical thinking skills. This is best achieved when teachers support, as appropriate, students' independent engagement with the learning outcomes.

Agricultural Science learning takes place in diverse settings. The learning outcomes provide frequent opportunities for students to engage in classroom and school laboratory learning, but also learning in settings such as farms, in green spaces, polytunnels and growing areas in the school and community, and agrifood settings. The practical learning students gain from tasks such as cultivating and growing, as well as the knowledge transfer gained from practitioners in these settings, further enhances their understanding of Agricultural Science. The 'Agricultural Engagement' section in each of the contextual strands supports the student-centred approach. The learning outcomes in these sections provide opportunities for students to experience agricultural science in hands-on ways and in authentic settings such as farms and growing areas in the school. However, these learning outcomes should be seen as a minimum requirement, and teachers are encouraged to avail of any opportunities throughout the specification to connect the theory aspects of the subject with practical learning and examples in diverse settings.

Providing opportunities for students to develop a range of inquiry skills will be necessary to progress along the continuum of inquiry[2]. Teachers are best positioned to make professional judgements on how to develop these skills with their students through an appropriate balance of teacher guidance and student self-direction. This is enabled through rich tasks that

[2] See Junior Cycle Science Specification (pp. 13-14) for further information on the continuum of inquiry.

are structured, appropriately scaffolded, and inclusive. Through such tasks, students design, conduct and report on their investigations. They confidently pose hypotheses, predict outcomes and record their results and conclusions. They select and manipulate apparatus safely to test their hypotheses. Students research socio-scientific issues and weigh perspectives to understand the relevance of Science in solving problems. They think critically, solve problems, examine issues, and develop investigative skills through research and experimentation. By engaging in well-structured group discussions, students will develop skills in reasoned argument, listening to each other and reflecting on their own work and that of others.

Making connections is a key component of Agricultural Science learning. Students learn to make connections between agricultural contexts and the science underpinning them by talking, thinking, making, problem-solving, and investigating. They also make connections through models – words, diagrams, equations, physical models, or simulations that represent ideas, structures, processes and systems in agriculture. They will develop and use models to describe, explain, make predictions and solve problems, recognising that all models have limitations and can be refined based on new information gained through scientific inquiry. Scientific practices are best learned by doing, and in planning for teaching and learning, teachers should provide ample opportunity for students to engage with the scientific practices set out in the unifying strand. Teachers can support students to progressively build their ability to engage with the learning outcomes of the unifying strand, realised through the content and activities of the contextual strands. Whilst the contextual strands set out situations where students are required to gather primary data to verify observations and relationships, this is a minimum requirement, and it is not expected that practical opportunities would be limited to these situations. The practical nature of Agricultural Science means students investigate a variety of living things. They will gather primary data and engage with secondary data on, for example, soil, microorganisms, plants, and farm animals. Teachers should always ensure that students work safely in line with guidance from the Health and Safety Authority, and in line with guidance from the Department of Education and Youth around investigations involving living things.

Through cross-cutting themes, students will integrate their knowledge and understanding of agriculture with the ethical, social, economic, and environmental implications of agricultural practices. By critically examining agricultural issues in the public domain, they develop skills in scientific communication by collaborating to generate perspectives and share them with their peers.

Teachers can promote practices that support the development of students' independent investigative, research, and communication skills through targeted guidance and feedback, individual to students, that enables them to improve their work. Students vary in the amount and type of support they need to be successful. As well as varied teaching strategies, varied assessment strategies will support learning and provide information that can be used as feedback so that teaching and learning can be modified in ways that best suit individual students. By setting appropriate and engaging tasks, asking questions of varying cognitive demands and giving feedback that promotes learner autonomy, assessment will support learning as well as summarising achievement.

Assessment

Assessment in senior cycle involves gathering, interpreting, using and reporting information about the processes and outcomes of learning. It takes different forms and is used for a variety of purposes. It is used to determine the appropriate route for students through a differentiated curriculum, to identify specific areas of strength or difficulty for a given student and to test and certify achievement. Assessment supports and improves learning by helping students and teachers to identify next steps in the teaching and learning process.

As well as varied teaching strategies, varied assessment strategies will support student learning and provide information to teachers and students that can be used as feedback so that teaching and learning activities can be modified in ways that best suit individual learners. By setting appropriate and engaging tasks, asking questions and giving feedback that promotes learner autonomy, assessment will support learning and promote progression, support the development of student key competencies and summarise achievement.

Assessment for certification

Assessment for certification is based on the rationale, aim and learning outcomes of this specification. There are two assessment components: a written examination and an additional assessment component comprising an Agricultural Science in Practice Investigation. The written examination will be at higher and ordinary level. The Agricultural Science in Practice Investigation will be based on a common brief. Each component will be set and examined by the State Examinations Commission (SEC).

In the written assessment, Leaving Certificate Agricultural Science will be assessed at two levels, Higher and Ordinary (Table 1, page 11). Examination questions will require students to demonstrate learning appropriate to each level. Differentiation at the point of assessment

will also be achieved through the stimulus material used, and the extent of the structured support provided for students at different levels.

Assessment Component	Weighting	Level
Agricultural Science in Practice Investigation	40%	Common brief
Written examination	60%	Higher and Ordinary

Table 2 Overview of Assessment for Certification

Additional assessment component: Agricultural Science in Practice Investigation

The Agricultural Science in Practice Investigation provides an opportunity for students to display evidence of their learning throughout the course, in particular, the learning set out as outcomes in the unifying strand. It involves students completing a piece of work during the course and, in Year 2, submitting for marking to the State Examinations Commission (SEC), evidence of their ability to conduct scientific research on a particular issue and to conduct an experiment on an aspect(s) of that issue by gathering appropriate primary data. The assessment has been designed to be naturally integrated into the flow of teaching and learning and to exploit its potential to be motivating and relevant for students, to draw together the learning outcomes and cross-cutting themes of the course and to highlight the relevance of learning in Agricultural Science to their lives[3].

The senior cycle key competencies, developed by the students through all their learning in this course, will be applied through engagement with the Agricultural Science in Practice Investigation. The Agricultural Science in Practice Investigation provides opportunities for students to pursue their interests in Agricultural Science, to demonstrate their skills in scientific inquiry and scientific communication, to make their own investigative decisions, acquire a depth of conceptual understanding and self-regulate their own learning.

[3] It is envisaged that the AAC will take up to 20 hours to complete. Further details will be provided in the Guidelines to support the Agricultural Science in Practice Investigation.

Investigation brief

An *Investigation Brief* will be published annually by the SEC in term 2 of Year 1 of the course. As well as setting out the specific requirements of the Agricultural Science in Practice Investigation, the brief will:

- allow students to develop their thinking and ideas on aspect(s) they would like to investigate, related to the brief
- facilitate teachers and students in their planning
- include stimulus material to set a context for the investigation
- allow students to develop an investigative log that they can draw upon as they complete their investigation.

Building on their learning to date, students will learn more about the nature of investigation through research and experimentation. Students should be empowered in realising that research and experimentation are more about engaging with and learning from the process, rather than seeking a *perfect answer*. Students should give an authentic account of how their investigative work unfolds, discuss and explain the outcomes of their investigation and how they might revise aspects of the process.

To complete the Agricultural Science in Practice Investigation, students carry out the following, related to an issue within the SEC brief:

- Scientific research: they gather, process and evaluate information from secondary sources. The knowledge gained from this phase of the investigation may help to inform their experimental work.
- An experiment: they generate a hypothesis, plan, and design their experiment. They carry out their experiment and gather appropriate primary data. Once they have gathered their primary data, they analyse the data and form conclusions.

Students communicate their investigative findings using relevant scientific terminology and representations and develop an evidence-based argument in response to the brief. Upon completion, students submit a report of their investigation in Year 2 in a format prescribed by the SEC.

Schools have a high degree of autonomy in planning and organising the completion of the investigation. A separate document, *Guidelines for the Agricultural Science in Practice Investigation*, gives guidance on a range of matters related to the organisation, implementation, and oversight of the investigation.

Descriptors of quality for the Agricultural Science in Practice investigation

The descriptors below relate to the learning achieved in the Agricultural Science in Practice Investigation. In particular, the investigation requires students to:

- demonstrate knowledge and understanding of agricultural concepts
- demonstrate research and experimental investigative skills
- communicate their investigative findings appropriately and effectively
- relate their investigative work to agricultural contexts.

	Students demonstrating a high level of achievement	Students demonstrating a moderate level of achievement	Students demonstrating a low level of achievement
Knowledge and understanding	engage thoroughly with the concept(s) being investigated; explain clearly and accurately, using appropriate means, the agricultural idea(s) and application(s) involved; where applicable gather, process and evaluate information from a variety of secondary sources, pose a testable hypothesis that is underpinned by scientific theory and clearly describe the purpose of the investigation.	have a good engagement with the concept(s) being investigated; describe the agricultural idea(s) and application(s) involved; where applicable, gather and summarise information from secondary sources, pose a testable hypothesis and outline the purpose of the investigation.	have a limited engagement with the concept(s) being investigated; outline the agricultural idea(s) and application(s) involved; are provided with a testable hypothesis to investigate.
Investigating (research and experimentation)	use a large number of varied, balanced and referenced sources; use a clear investigative design and thorough appropriate methods to collect high quality primary data and evaluate the reliability of any secondary sources used; draw a valid conclusion(s) justified by	use a number of balanced mostly referenced sources; use an investigative design and appropriate methods to collect good quality primary data and consider the reliability of any secondary sources used; draw a conclusion(s) that relates to any	use some referenced sources; use investigate design and methods to collect primary data that are unclear and make little effort to consider the reliability of any secondary sources used; draw a limited conclusion(s) and fail to

	evidence and relating to any hypotheses made; evaluate the investigation acknowledging sources of error in the investigative design.	hypotheses made and identify potential sources of error in the investigative design; reflect on what worked and did not work.	identify potential sources of error in the investigative design; give an incoherent, illogical, or idealised reflection.
Communicating	report on the design and conduct of their investigation that includes high quality data presentation and analysis; include, at their own initiative, new direction(s) or approach(es) to experimentation and research as the work progresses; provide an evidence-based argument in response to the brief.	report on the design and conduct of their investigation that includes good quality data presentation and analysis; consider a minor extension(s) or alteration(s) to the plan; make claims based on evidence.	provide a limited report on the design and conduct of their investigation; limited data presentation and analysis; show no evidence of ongoing reflection; limited or no use of evidence to support any claims made.
Relating to agriculture	offer a considered reflection locating the research and experimental outcome(s) of the investigation within broader issues relating to a local and global agricultural context(s) as appropriate.	reflect on how the research and experimental outcome(s) of the investigation relate to a real-world agricultural issue(s).	make limited links between the outcome(s) of the investigation and a real-world agricultural issue(s).

Table 3 Descriptors of Quality: Agricultural Science in Practice Investigation

Written examination

The written examination will consist of a range of question types. The senior cycle key competencies (Figure 2) are embedded in the learning outcomes of this specification and will be assessed in the context of the learning outcomes. The written examination paper will include a selection of questions that will assess, appropriate to each level:

- the learning described in the three contextual strands of the specification and the unifying strand
- application of Agricultural Science to issues relating to the cross-cutting themes—sustainability health, and technology.

Reasonable accommodations

This Leaving Certificate Agricultural Science specification requires that students engage with the nature of the subject on an ongoing basis throughout the course. The assessment for certification in Leaving Certificate Agricultural Science involves a written examination worth 60% of the available marks and an additional component worth 40%. In this context, the scheme of Reasonable Accommodations, operated by the State Examinations Commission (SEC), is designed to assist students who would have difficulty in accessing the examination or communicating what they know to an examiner because of a physical, visual, sensory, hearing, or learning difficulty. The scheme assists such students to demonstrate what they know and can do, without compromising the integrity of the assessment. The focus of the scheme is on removing barriers to access, while retaining the need to assess the same underlying knowledge, skills, values, and dispositions as are assessed for all other students and to apply the same standards of achievement as apply to all other students. The Commission makes every effort when implementing this scheme to accommodate individual assessment needs through these accommodations.

There are circumstances in which the requirement to demonstrate certain areas of learning when students are being assessed for certification can be waived or exempted, provided that this does not compromise the overall integrity of the assessment.

More detailed information about the scheme of Reasonable Accommodations in the Certificate Examinations, including the accommodations available and the circumstances in which they may apply, is available from the State Examinations Commission's Reasonable Accommodations Section.

Before deciding to study Leaving Certificate Agricultural Science, students, in consultation with their school and parents/guardians should review the learning outcomes of this

specification and the details of the assessment arrangements. They should carefully consider whether or not they can achieve the learning outcomes, or whether they may have a special educational need that may prevent them from demonstrating their achievement of the outcomes, even after reasonable accommodations have been applied. It is essential that if a school believes that a student may not be in a position to engage fully with the assessment for certification arrangements, they contact the State Examinations Commission.

Leaving Certificate grading

Leaving Certificate Agricultural Science will be graded using an 8-point grading scale. The highest grade is a Grade 1; the lowest grade is a Grade 8. The highest seven grades (1-7) divide the marks range 100% to 30% into seven equal grade bands 10% wide, with a grade 8 being awarded for percentage marks of less than 30%. The grades at Higher level and Ordinary level are distinguished by prefixing the grade with H or O respectively, giving H1-H8 at Higher level, and O1-O8 at Ordinary level.

Grade	% marks
H1/O1	90-100
H2/O2	80<90
H3/O3	70<80
H4/O4	60<70
H5/O5	50<60
H6/O6	40<50
H7/O7	30<40
H8/O8	<30

Table 4 Leaving Certificate grading scale.

Appendix 1 Glossary of action verbs

This glossary is designed to clarify the learning outcomes. Each action verb is described in terms of what the learner should be able to do once they have achieved the learning outcome. This glossary will be aligned with the command words used in the assessment.

Action verb	Students should be able to
Analyse	study or examine something in detail, break down in order to bring out the essential elements or structure; identify parts and relationships, and to interpret information to reach conclusions
Apply	select and use information and/or knowledge and understanding to explain a given situation or real circumstances
Appreciate	recognise the meaning of, have a practical understanding of
Compare	give an account of the similarities and (or) differences between two (or more) items or situations, referring to both (all) of them throughout
Conduct	perform an activity
Consider	describe patterns in data; use knowledge and understanding to interpret patterns; make predictions and check reliability
Describe	develop a detailed picture or image of, for example a structure or a process, using words or diagrams where appropriate; produce a plan, simulation or model
Design	conceive, create and execute according to plan
Discuss	offer a considered, balanced review that includes a range of arguments, factors or hypotheses; opinions or conclusions should be presented clearly and supported by appropriate evidence
Distinguish	make the differences between two or more concepts or items clear
Evaluate (data)	collect and examine data to make judgments and appraisals; describe how evidence supports or does not support a conclusion in an inquiry or investigation; identify the limitations of data in conclusions; make judgments about the ideas, solutions or methods
Evaluate (ethical judgement)	collect and examine evidence to make judgments and appraisals; describe how evidence supports or does not support a judgement; identify the limitations of evidence in conclusions; make judgments about the ideas, solutions or methods
Explain	give a detailed account including reasons or causes
Explore	observe, study, in order to establish facts
Identify	recognise patterns, facts, or details; provide an answer from a number of possibilities; recognize and state briefly a distinguishing fact or feature
Illustrate	use examples to describe something

Investigate	observe, study, or make a detailed and systematic examination, in order to establish facts and reach new conclusions
Justify	give valid reasons or evidence to support an answer or conclusion
Measure	quantify changes in systems by reading a measuring tool
Model	represent an idea, structure, process or system through a variety of means such as words, diagrams, equations, physical models or simulations; use models to describe, explain, make predictions and solve problems, recognising that all models have limitations.
Organise	arrange; to systematise or methodise
Outline	give the main points; restrict to essentials
Plan	devise or project a method or a course of action
Pose	put forward for consideration
Produce	bring into existence by intellectual or creative ability
Recognise	identify facts, characteristics or concepts that are critical (relevant/appropriate) to the understanding of a situation, event, process or phenomenon
Reflect	consider in order to correct or improve
Research	inquire specifically, using involved and critical investigation
Relate	associate, giving reasons
Review	re-examine deliberately or critically, usually with a view to approval or dissent; to analyse results for the purpose of giving an opinion
Use	apply knowledge or rules to put theory into practice