

Unit 3: Understand the Principles of Plant Science

Unit code:	L/600/9149
QCF Level 3:	BTEC National
Credit value:	5
Guided learning hours:	30

● Aim and purpose

This unit aims to introduce learners to an understanding of plant science and how this can be applied in practice. It is designed for learners in centre-based settings looking to progress into the sector or onto further/higher education.

● Unit introduction

All land-based sectors and many applied science industries are dependent, directly or indirectly, on plants. Understanding plant processes is essential for learners wishing to become involved in the land-based or applied science industries, particularly those enterprises which are primarily plant-focused.

Learners will develop an understanding of internal and external plant structures and their function in the context of the plants commonly used within the relevant land-based and/or applied science industries. They will gain an understanding of important life processes such as photosynthesis and respiration, and the uptake and transport of water and nutrients. Learners will look at how plants grow and develop and will study plant life cycles and reproduction in different plant species.

● Learning outcomes

On completion of this unit a learner should:

- 1 Understand the function of plant structures
- 2 Understand the main processes of plant physiology
- 3 Understand plant growth and development.

Unit content

1 Understand the function of plant structures

Internal and external structures: external structures (roots, shoots, stem, leaves, buds, flowers, fruits, seeds); internal structures (cell structure, cytoplasm, organelles, parenchyma, collenchyma, sclerenchyma, xylem tissue, phloem tissue, cambium, epidermis, guard cells, stomata); specialised cells, tissues and organs eg pericycle, endodermis, lenticels, cotyledons, stolons, rhizomes, storage organs

2 Understand the main processes of plant physiology

Photosynthesis: equation for photosynthesis; function of chlorophyll; functionality of guard cells and stomata; factors limiting the rate of photosynthesis (temperature, carbon dioxide, leaf colour, light, water availability)

Respiration: definition of aerobic and anaerobic respiration; equation for aerobic respiration; structure and function of mitochondria; diffusion; compensation point; factors influencing the rate of respiration eg temperature, water availability, seasonal growth

Uptake, transport and loss of water and nutrients: osmosis; diffusion; plasmolysis; turgor; translocation; transpiration; factors influencing transpiration eg temperature, humidity, air movement, water supply, light, stomata

Industry context: use of plant physiology knowledge in applied environmental and land-based scenarios

3 Understand plant growth and development

Plant growth and development: life cycle types eg ephemeral, annual, biennial, perennial; process and stages of germination; types of germination eg epigeal, hypogeal; types of reproduction (sexual reproduction eg flower structures, pollination and fertilisation, seed production, dispersal; asexual reproduction eg vegetative propagation, parthenogenesis); primary growth of shoots and roots (cell division, cell expansion, cell differentiation, apical meristems, lateral meristems)

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
P1 identify the major internal and external structures of plants		
P2 explain the function of the major plant structures [IE]	M1 discuss the link between structure and function for major plant structures	
P3 explain the major processes of plant physiology [IE]		
P4 identify the factors which can limit the rate of photosynthesis	M2 explain how a knowledge of plant physiology is applied to plant husbandry in a selected industry.	D1 discuss the manipulation of plant physiology to enhance plant performance in a selected industry.
P5 explain the life cycle of selected plants. [IE]		

PLTS: This summary references where applicable in the pass criteria, in the square brackets, the elements of the personal, learning and thinking skills. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers	RL – reflective learners TW – team workers	SM – self-managers EP – effective participators
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Essential guidance for tutors

Delivery

Delivery of this unit will involve practical assessments, written assessment, visits to suitable collections and will have links to industrial experience placements.

As a science-based unit it is important that delivery of the theory is supported by appropriate supervised laboratory practicals. Health and safety issues relating to working with plant materials must be stressed and reinforced regularly, and risk assessments must be undertaken before any practical activities.

Delivery of learning outcome 1 will be largely classroom based, supported by independent learner research, but should be enhanced by appropriate laboratory activity, such as plant dissection and microscope viewing of plant cells. Learners will need to gain an understanding of how the structure of plant components leads to their functionality.

Delivery of learning outcome 2 is likely to include a number of laboratory practicals, for example investigating factors that limit the rate of photosynthesis, and using a photometer to investigate water uptake in plants. Guest speakers could also add vocational relevance, for instance a commercial grower or agronomist.

Learning outcome 3 covers plant life cycles, plant growth and development. Tutors should ensure that they have access to a suitable range of plants that can be studied at appropriate development stages. Tutors can tailor the actual species to the sector and/or local environment. Learning outcome 3 is likely to be delivered by a combination of formal lectures, discussion, site visits, practicals, and independent learner research.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan gives **an indication of the volume of learning it would take the average learner** to achieve the learning outcomes. It is **indicative and is one way of achieving the credit value**.

Learning time should address all learning (including assessment) relevant to the learning outcomes, regardless of where, when and how the learning has taken place.

Topic and suggested assignments/activities and/assessment
Intro to unit.
Assignment 1: Plant Structure and Function (P1, P2, M1)
Introduction to topic and brief.
Classroom based: introduction to plant structures and function.
Laboratory practical: plant dissection.
Laboratory practical: microscopic viewing of plant structure.
Discussion of function, and the link between structure and function.
Personal study/tutor support/assignment completion.
Assignment 2: Plant Processes (P3, P4, M2, D1)
Introduction to topic and brief.
Theory: photosynthesis, discussion of limiting factors.
Laboratory practicals: limiting factors.

Topic and suggested assignments/activities and/assessment
Theory: respiration, compensation point.
Theory: transport systems in plants.
Laboratory practical: water uptake in plants in different conditions.
Research followed by classroom activity: how to use knowledge of plant processes in plant husbandry.
Personal study/tutor support/assignment completion.
Assignment 3: Plant Life Cycles (P5)
Introduction to topic and brief.
Practical: conditions needed for germination.
Theory: types of reproduction in plants, stages of reproduction, types of life cycle.
Theory – growth and development in plants.
Personal study/tutor support assignment completion.
Unit review.

Assessment

In order to achieve a pass learners must meet the five pass criteria.

For P1, learners need to identify the major internal and external plant structures as shown in the unit content. This could be achieved through annotating a diagram, a class-based identification assessment, or by producing an annotated poster. This could link to P2, where learners are required to identify the function of the major structural components. This could be completed by annotating further the diagram completed for P1 so that the function is clearly shown. It is important that plant species are chosen that enable full completion of the range shown in the unit content.

For P3, learners need to explain the major processes of plant physiology. This should include an explanation of photosynthesis, respiration and water and nutrient uptake and transportation. Evidence may take the form of a written report, illustrated leaflet, verbal presentation or project.

For P4, learners need to identify the factors which limit the rate of photosynthesis. Evidence for this could be linked to P3, but could also include the write up from a laboratory experiment investigating photosynthesis.

For P5, learners need to explain plant life cycles, including growth, development and reproduction. This should include a minimum of two plants with different types of life cycle, which may be selected by the tutor or through discussion with the learners. Learners could include annotated diagrams showing the botanical features involved at each stage. Tutors should try to make this criterion as relevant as possible to the vocational area of the learners. The species studied could include weed species. Evidence for this could take the form of a pictorial presentation with notes (possibly using appropriate software or an overhead projector), an annotated poster or a project.

To achieve a merit learners must meet the two merit criteria in addition to fully meeting the pass criteria.

For M1, learners need to extend the assessment evidence produced for P1 and M1 to explain the link between structure and function of the major plant components. This could be achieved through further annotations of the work produced for P1 and P2.

For M2, learners need to demonstrate an understanding of the application of a knowledge of plant processes. Learners will need to explain how at least husbandry in plant production is derived from at least one major plant process. The industry selected should link to learners' vocational interests, and may be selected by the tutor or through discussion with the learners. The use of plant husbandry could be in connection to grass or forage crop production if this is of more vocational relevance to the learner than arable or horticultural cropping.

To achieve a distinction learners need to meet the distinction criterion as well as fully meeting those for pass and merit.

For D1, learners are required to discuss the manipulation of plant physiology to enhance plant performance in a selected industry. Learners' evidence must be contextualised, giving examples of manipulation undertaken in a selected industry. This may be the same as that used to provide evidence for other Assessment and grading criteria. For example, learners may look at the manipulation of woodland canopies to create clearings, the irrigation of crops, or the use of controlled environments for crop storage.

Programme of suggested assignments

The following table shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, M1	Plant Structure and Function	Create an annotated poster which illustrates the major plant structures and explains their functions. Explain how the structure of different plant parts links to their function.	Annotated poster.
P3, P4, M2, D1	Plant Processes	You have been commissioned by a group of local farmers to create a leaflet which explains how plants function, and what husbandry techniques they can use, based on plant science, to enhance plant growth. You should include the major plant processes of photosynthesis, respiration and water and nutrient uptake and transportation.	Illustrated leaflet.
P5	Plant Life Cycle	Write an illustrated report explaining the life cycle of selected plants.	Written report.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC land-based sector suite. This unit has particular links with:

Level 2	Level 3
Introduction to Animal and Plant Biology	Undertake an Investigative Project in the Land-based Sector
	Undertake and Review Work Experience in the Land-based Industries

Essential resources

There are many opportunities for practical and experimental work in this unit. Therefore there should be access to adequate field and laboratory facilities for the investigation of plant structures, germination, photosynthesis, osmosis and transpiration. A suitable range of plants and plant material should be available for learners to study.

There should be access to light microscopes to study cell structures. Learners should have access to current health and safety regulations and equipment.

Access to library resources and the internet for research and reference must be available.

Employer engagement and vocational contexts

It is important that this subject is studied in the context of plants commonly used in learners' vocational area to ensure relevance and interest to the learners. Links with employers could be beneficial in illustrating the link between plant science and husbandry.

Indicative reading for learners

Textbooks

Barnes C and Poore N — *Plant Science in Action* (Hodder Arnold, 1994) ISBN 978-0340600993

Cutler D, Botha T and Stevenson D — *Plant Anatomy: An Applied Approach* (Blackwell Publishing, 2007) ISBN 978-1405126793

Green N P O, Stout G W and Taylor D J — *Biological Science 1 and 2, Third Edition* (Cambridge University Press, 1997) ISBN 978-0521567213

Hill-Cottingham P and Hill-Cottingham D — *Plant Science (Biology Advanced Studies Series)* (Blackie Schools, 1992) ISBN 0216930316

Lockhart J A R et al — *Lockhart and Wiseman's Introduction to Crop Husbandry, 7th Edition* (Butterworth-Heinemann, 1993) ISBN 978-0080420035

Raven P, Johnson G, Singer S and Losos J — *Biology, 7th Edition* (McGraw-Hill Higher Education, 2004) ISBN 9780072921649:

Ridge I — *Plants* (Oxford University Press, 2002) ISBN 978-0749217525

Roberts M, Reiss M and Monger G — *Biology: Principles and Processes* (Nelson Thornes, 2004) ISBN 0174481764

Roberts M, Reiss M and Monger G — *Advanced Biology* (Nelson Thornes, 2000) ISBN 9780174387329

Soffe R — *The Agricultural Notebook, 20th Edition* (Blackwell Science, 2003) ISBN 978-0632058297

Stern K — *Introductory Plant Biology, 9th Edition* (McGraw-Hill Education, 2007) ISBN 978-0071102179

Journals

Arable Farming

Crops

Crop Science

Landwards

Websites

www.agrifor.ac.uk

Intute: Agriculture, food and forestry

www.bbsrc.ac.uk

The Biotechnology and Biological Sciences Research Council

www.images.botany.org

Botanical Society of America

www.defra.gov.uk

Department for Environment, Food and Rural Affairs

www.hse.gov.uk

Health and Safety Executive

www.lantra.co.uk

Lantra

www.rothamsted.ac.uk

Rothamsted Research

www.saps.plantsci.cam.ac.uk

Science and Plants for Schools

www.sebiology.org

Society for Experimental Biology

Delivery of personal, learning and thinking skills (PLTS)

The following table identifies the PLTS opportunities that have been included within the assessment criteria of this unit:

Skill	When learners are ...
Independent enquirers	explaining the function of plant structures explaining plant processes explaining plant life cycles.

Although PLTS opportunities are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Independent enquirers	researching how plant physiology affects husbandry
Team workers	carrying out laboratory practicals
Self-managers	independently completing assignment work.

● Functional Skills — Level 2

Skill	When learners are ...
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	researching plant structure and function researching plant life cycles researching plant processes
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: <ul style="list-style-type: none"> • text and tables • images • numbers • records 	producing written assignments
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	discussing choice of selected plant
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching plant structure and function researching plant life cycles researching plant processes
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	explaining plant structure and function explaining plant processes identifying the limiting factors for photosynthesis explaining plant life cycles.