Unit 11: Understand the Principles of Advanced Horticultural Science

Unit code: L/600/9846

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

Aim and purpose

This unit aims to provide learners with an understanding of the principles of advanced horticultural science and how these can be applied in practice. This unit is primarily aimed at learners within a centre-based setting looking to progress into the sector or further education and training.

Unit introduction

Learners will look into how external and internal factors control the development of flowers, fruit and seeds during sexual reproduction of plants. They will study how plant growth is controlled by light, gravity and plant growth regulators and they will look at how plants have adapted their structures and physiology to survive in a diverse range of habitats.

New methods of plant breeding are becoming increasingly important in a fast changing world. This module will provide learners with an introduction to the study of genetics and plant breeding. This will include a look at the modern plant breeding techniques which are being used to help us to produce plants that can survive in changing environmental conditions.

Learners will also learn more about the processes involved in the development and management of soils. They will move on from the previous studies of the properties of topsoil to look at the whole soil in terms of soil profiles and soil classification. They will look at how nutrients are recycled in soils and at how soils can be managed sustainably.

Learning outcomes

On completion of this unit a learner should:

1 Understand the physiology of flowers and seeds

2 Understand the principles and processes of plant growth regulation

3 Understand plant breeding and genetics

4 Understand plant adaptations in response to environment

5 Understand the characteristics and classification of soils.

Unit content

1 Understand the physiology of flowers and seeds

Photoperiodism: long day, short day and day neutral plants; night breaks

Vernalisation: influences on seeds and bulbs

Pollination: processes involved in transferring pollen; advantages and mechanisms of cross-pollination

Seed and fruit maturation: processes of seed and fruit maturation; relationship with food and seed storage; seed dispersal

Germination: stages of germination; gymnosperms; angiosperms; seed components; conditions required for germination

Dormancy: seeds and buds; definition and purpose; mechanisms; methods for breaking dormancy

2 Understand the principles and processes of plant growth regulation

Plant growth regulators: characteristics of a plant growth regulator; involvement of auxins, gibberellins, abscisic acid and ethylene in the plant processes of germination, growth and dormancy

Use of synthetic plant growth regulators eg rooting powders, growth retardants, breaking dormancy in seeds, growth stimulants

Phototropism

Gravitropism

3 Understand plant breeding and genetics

Mitosis and meiosis: processes involved and differences between (naming of stages not required); chromosome and chromatid

Transcription and translation: basic structure of DNA, RNA and proteins; basic processes of translation and transcription

Genetics: genes and alleles; dominant and recessive genes; homozygous and heterozygous genotypes; phenotype; monohybrid and dihybrid crosses

Plant breeding, genetic manipulation and tissue culture: basic techniques of genetic manipulation and tissue culture; comparison of these with more traditional methods of plant breeding; consideration of the pros and cons of such techniques in sustainable management of plants and environmental protection

4 Understand plant adaptations in response to environment

Abiotic factors: eg shade, drought, low nutrient levels

Biotic factors: eg grazing, pests, pollinating agents

Structural adaptations to environmental conditions: eg sun and shade leaves, waxy cuticles and hairs, thorns and spines, storage organs, long tap roots, rosette growth

Physiological adaptations to environmental conditions: eg low respiration rates, osmoregulation, association with mycorrhizae, chemical defences, phototropism; floral structure and its relationship with pollinating agents; use of adapted plants to allow sustainable plant management

5 Understand the characteristics and classification of soils

Soil profiles and classification: brown earth; gley soil; podsol; calcareous; management of different soil classes

Nutrient recycling in soils: nitrogen and calcium cycles

Control of nutrient availability in soils: by pH, texture, structure and cropping; sustainable management of soils

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 describe photoperiodism in relation to flowering and other plant processes	**M1** discuss how physiological processes in a plant interact in the production and germination of seeds	**D1** explain how plant growth and reproductive processes can be manipulated by use of appropriate management practices
P2 explain the processes of dormancy in buds and seeds, vernalisation and maturation of seeds and fruits		
P3 describe the stages and processes involved in germination including breaking dormancy where applicable		
P4 explain the responses to and interactions of natural plant hormones (plant growth regulators) [IE]		
P5 review the effects synthetic plant growth regulators		
P6 describe the processes of mitosis and meiosis in plants	**M2** compare the use of traditional and more modern methods in plant breeding	**D2** explain how traditional and modern techniques of plant breeding could be used to help allow sustainable management of plants
P7 explain Mendel's laws of inheritance, segregation, dominance and recession		
P8 evaluate the uses of genetic manipulation and tissue culture in plant breeding [TW]		

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:**
P9 describe the variations in plant physiology in relation to environmental conditions	**M3** describe how plant adaptations to biotic and abiotic factors enables plants to survive in stressful environments	**D3** explain how a knowledge of plant adaptations can be used to choose plants in a way that allows more sustainable management of plants.
P10 review the diversity of vegetative structure in response to environmental conditions		
P11 review the diversity of floral structure and its relationship with pollinator agents [EP]		
P12 explain the cultivations and management techniques that are appropriate to soils of different classes	**M4** compare the availability and recycling of nutrients in contrasting soil classes.	
P13 explain the nitrogen and calcium cycles and the role of soil texture, structure, pH and cropping on the availability of nutrients.		

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	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

Delivery of this unit should use a wide range of different techniques. This unit is likely to be delivered by a series of lectures and discussions accompanied by laboratory and field practical activities and visits to suitable plant collections. Learners should be encouraged to carry out research using the internet and/or library resources and should be helped to link this module to industrial experience wherever possible.

Whichever delivery methods are used, it is essential that tutors emphasise the importance of sustainable environment management. Health and safety issues relating to working with soil and plant materials must be stressed and regularly reinforced, and risk assessments must be undertaken prior to practical activities.

Learners should be introduced to a wide range of plant examples. These should include a range of flowers, fruit and seed to enable learners to look at the structures and processes involved in flowering, seed and fruit development and germination. A wide range of plants which show different adaptations to a variety of abiotic and biotic environmental factors should also be studied.

Learners should be given the opportunity to carry out a number of practical activities to study plant physiology. These might include investigating the effects of naturally occurring and synthetic growth regulators on growth or development. They should also carry out practical work to investigate the effects of phototropism and gravitropism. Visits to commercial growers might allow learners to consider how plant growth and development can be manipulated by appropriate management practices.

Learners should be given the opportunity to observe plant cells at various stages of mitosis and meiosis. This could be by means of observing pre-prepared slides of root tip squashes (mitosis) or anther squashes (meiosis) down a microscope. Alternatively appropriate visual or audio-visual resources could be used. Learners should be allowed to observe the results of simple monohybrid and dihybrid crosses either by means of growing commercially available seeds or, where this is not possible, by means of visual or audio-visual resources. They should also be shown standard methods to find the solutions to simple genetics problems. Where possible, learners should be given the opportunity to visit commercial labs, or growers, that are using micropropagation techniques.

Learners should be given the opportunity to study soil profiles in the locality and introduced to other types of soils by means of visual or audio-visual resources. They should be involved in carrying out tests on different soil horizons. Tests might include a hand texture test, a pH test, a test for organic matter content and commercially available test kits for nutrient levels. The soil samples being tested should, where possible, be collected by the learners themselves and might be associated with sites that they are studying in other units or that relate to their work placements.

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
Assignment 1: Physiology Workbook (P1, P2, P3, P4, P5, M1, D1)
Theory sessions.
In class work on assessment tasks.
Individual work on assessment and personal study.
Assignment 2: Plant Breeding Factsheet (P6, P7, P8, M2, D2)
Theory sessions.
Visit to growers.
In class work on assessment tasks.
Assignment 3: Plant Adaptations Leaflet/Interpretation Boards (P9, P10, P11, M3, D3)
Individual work on assessment and personal study.
Theory sessions.
Visit to plant collection.
Individual work on assessment and personal study.
Assignment 4: Soil Report (P12, P13, M4)
Theory sessions.
Site visit/fieldwork.
In class work on assessment tasks.
Individual work on assessment and personal study.
Unit review.

Assessment

For P1, P2, P3, P4 and P5, learners should demonstrate an ability to describe and explain the processes involved in the production and germination of a seed as well as explain the role of plant growth regulators in plant growth and development. Assessment could be in the form of a workbook containing a series of short tasks and questions related to activities/discussions in class on photoperiodism, vernalisation, fruit development, germination, dormancy and plant growth regulators, some of which could be answered using knowledge gained in class sessions and some of which would require further individual research. Alternatively, these criteria might be assessed by an end-of-topic test or a series of short tests.

For M1, learners should discuss how the physiological processes in a plant interact in the production and germination of seeds. For D1 learners should be able to explain how management practices in their industry work by manipulating the physiology of the plant. These could be assessed by means of questions at the end of the plant physiology workbook for P1-P5 or as a separate written assignment.

For P6, P7 and P8, learners need to demonstrate their understanding of traditional and modern techniques of plant breeding and in the process demonstrate an understanding of cell division by mitosis and meiosis. Assessment could be in the form of a fact sheet that explains a) traditional plant breeding techniques and their reliance on the variation produced by meiosis, and b) more modern techniques that rely on the production of identical cells by mitosis. An alternative form for this assessment might be a magazine article or a visual presentation with notes.

M2 asks learners to compare the pros and cons of traditional and modern techniques of plant breeding. D2 asks learners to consider how production of new varieties, by both traditional and more modern techniques of plant breeding has been, or could be, used to help allow more sustainable growth and management of plants. Assessment of M2 and D2 could be included in the plant breeding fact sheet.

For P9, P10 and P11, learners need to describe the diversity of plant adaptations which allow them to live where they do. M3 then asks them to describe how these adaptations work and D3 asks them to explain how correct choice of plants, with appropriate adaptations, can allow more sustainable management. Assessment of these criteria could involve asking learners to produce either a leaflet or a series of interpretation boards that could be used to inform visitors to a plant collection about these issues.

For P12 and P13, learners should demonstrate that they can suggest suitable cultivation and management techniques for different classifications of soils. They should also be able to demonstrate at least a basic understanding of the factors controlling nutrient availability and nutrient recycling in soils (including nitrogen and calcium). Assessment of this learning outcome is likely to be in the form of a report on two (or more) sites with contrasting soil types. For a pass (P12 and P13) the report should include: the soil classification for two sites; the features of soils of these types in terms of soil texture, soil structures, pH and cropping/ vegetation; a brief discussion of what these features mean for nutrient availability; a summary of the nitrogen and calcium cycles; and a summary of the management techniques suitable for soils of these classes.

For a merit (M4) the report should compare the availability and recycling of nutrients at the two sites in relation to their classification.

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, P3, P4, P5, M1, D1	Physiology Workbook	Complete a series of written tasks and questions to show your understanding of the physiology of flowers and seeds and of how plant growth is regulated by hormones, light and gravity.	Completed workbook.
P6, P7, P8, M2, D2	Plant breeding Factsheet	Create a factsheet that explains and contrasts traditional and modern methods of plant breeding and explains how such techniques help us to manage our environment more sustainably.	Written evidence.
P9, P10, P11, M3, D3	Plant Adaptations Leaflet/Interpretation Boards	Produce a leaflet or set of interpretation boards to inform visitors to a plant collection about the adaptations plants use to survive adverse environmental conditions. Include information on how we can use a knowledge of these to inform our choice of plants to allow more sustainable plant management in the light of climatic changes.	Written evidence.
P12, P13, M4	Soil Report	Write a report on the features of two contrasting soils and compare the availability and recycling of nutrients in each. Suggest how the soils can be managed sustainably and justify your suggestions.	Completed 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
Understand the Basic Principles of Plant Science	Understand the Principles of Plant Science
Understand the Basic Principles of Soil Science	Understand the Principles of Soil Science

Essential resources

There are opportunities for practical and experimental work in this unit. Therefore there should be access to adequate glasshouse and laboratory facilities for the investigation of tropisms and plant growth regulators. 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 division. Learners should have access to current health and safety regulations and equipment. Links with growers and plant collections will enable access to a range of soil types, growing regimes and a wider range of plant material.

Learners should be given access to computers for research and presentation of assignments.

Indicative reading for learners

Textbooks

Adams C R, Bamford K M and Early M P – *Principles of Horticulture* (Heinemann, 2008) ISBN 978-0750686945

Ashman M R and Puri G – *Essential Soil Science* (Blackwell Publishing, 2002) ISBN 9780632048854

Brown L V – *Applied Principles of Horticultural Science 2nd Edition.* (Butterworth and Heinemann, 2002) ISBN 978-0750653428

Capon B – *Botany for Gardeners Revised Edition.* (Timber Press, 2005) ISBN 978-0881926552

Ingram D S, Vince-Prue D and Gregory P J (Ed) – *Science in the Garden.* (RHS) (Blackwell Publishing, 2002) ISBN **MISSING**

Websites

www.defra.gov.uk	Department for Environment, Food and Rural Affairs
www.hse.gov.uk	Health and Safety Executive
www.images.botany.org	Botanical Society of America

www.landis.org.uk/downloads/downloads/structure_brochure.pdf
LandIS - A soils-based land information system

www.lantra.co.uk	Lantra Sector Skills Council

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	researching plant adaptations and techniques of plant breeding
Creative thinkers	connecting ideas as part of assessment activities
Effective participators	identifying opportunities for sustainable management of soils and plants.

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	planning practical activities researching plant adaptations and techniques of plant breeding
Team workers	carrying out practical activities
Effective participators	participating in practical activities and discussions.