



## RHS Qualifications

### RHS Level 3 Certificate in the Principles of Plant Growth, Health and Applied Propagation

Qualification Specification September 2019

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## 1. RHS Qualifications Contact Details

RHS Qualifications is the Awarding Organisation of the Royal Horticultural Society.

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RHS website: [rhs.org.uk/qualifications](https://rhs.org.uk/qualifications)

## 2. Equality and Diversity Policy Statement

RHS Qualifications is committed to policies that will promote equal opportunities in all its operations, regardless of age, disability, ethnic origin, gender, marital status, religion, sexual orientation or any other factor.

RHS Qualifications is committed to ensuring that there is no unfair discrimination in any of its operations and will take into account all current legislation in relation to the equality of opportunity.

RHS Qualifications will constantly monitor and review its policies and practices pertaining to equal opportunities, to ensure that they remain consistent with its equal opportunities objectives and continue to comply with all relevant legislation.

RHS Qualifications will strive to make awareness of and respect for equality and diversity, an integral part of the culture of the organisation.

A copy of the RHS Qualifications Equality and Diversity Policy is available on the RHS website.

### **3. RHS Level 3 Certificate in the Principles of Plant Growth, Health and Applied Propagation**

#### **3.1 Introduction**

This qualification provides a route to employment in professional horticulture by assessing knowledge of the scientific principles underpinning horticultural practices, and supports career development for those already working in the profession. It also provides a foundation for further learning or training in the field of horticulture.

Whilst there are no formal pre-requisites for entry to the qualification, it is strongly recommended that students who undertake this qualification have obtained the RHS Level 2 Certificate in the Principles of Plant Growth, Propagation and Development or equivalent before they commence on the course.

The qualification is on the Register of Regulated Qualifications.

Qualification Number: 601/0353/X

#### **3.2 Guided Learning Hours (GLH) and Total Qualification Time (TQT)**

The Guided Learning Hours (GLH) represent the time that the learner spends learning under the immediate guidance and supervision of a tutor and includes assessment by the tutor, as well as invigilated exams. Guided Learning Hours are always less than total qualification time, as learners are expected to complete a certain amount of study in their own time.

The Guided Learning Hours for this qualification are 105.

Total Qualification Time (TQT) includes the Guided Learning Hours and represents the notional time that an average learner could reasonably expect to take to complete the learning outcomes of the units to the standard determined by the assessment criteria, and gain the qualification. It includes all face-to-face contact with tutors as well as assessment time and unsupervised directed study, coursework and practice.

The Total Qualification Time for this qualification is 180.

#### **3.3 Teaching Pattern**

The qualification is designed to be studied on a part-time basis. No particular teaching pattern is specified, and centres offering courses leading to the qualification are free to define their own teaching structure and teaching hours.

### 3.4 Qualification Structure

The qualification will be awarded to those who successfully pass the following four mandatory units:

RHS Ref	Unit	Level
R3101	Plant taxonomy, structure, and function Unit reference number H/505/2966	3
R3102	The root environment, plant nutrition and growing systems Unit reference number M/505/2839	3
R3103	The management of plant health Unit reference number D/505/2934	3
R3104	Understanding applied plant propagation Unit reference number J/505/2850	3

### 3.5 Assessment

Each unit will be assessed by a separate written examination covering all learning outcomes specified in the unit.

Examinations must be taken in a centre approved by RHS Qualifications, or under arrangements for exceptional supervision agreed by RHS Qualifications.

Examinations must be conducted in accordance with the RHS Regulations for the Conduct of Examinations.

Examinations will be offered twice a year in February and June.

Past examination papers including the examiner's comments are published for the past four examination sessions. These are available for download under the appropriate qualification section of the RHS website.

### 3.6 Language

Examinations will be offered in English.

### 3.7 Learning Resources

There is a wide range of books and other learning resources published which support the studies of those learning horticulture. RHS Qualifications does not recommend or endorse any specific learning resources as meeting the needs of learners studying for RHS qualifications. Learners are encouraged to seek guidance from their tutors on which resources best support their studies, or to choose the most appropriate resources for their needs from the wealth of material available.

### 3.8 Grading

A unit will be awarded to a candidate who achieves a mark of 50% or more in the written examination for that unit.

Where a candidate achieves a mark of 70% or more in the examination for the unit, the unit will be awarded with commendation.

RHS Ref	Unit	Mark	Pass with Commendation	Pass
R3101	Plant taxonomy, structure, and function	100	70	50
R3102	The root environment, plant nutrition and growing systems	100	70	50
R3103	The management of plant health	60	42	30
R3104	Understanding applied plant propagation	40	28	20

Where a candidate receives commendation in all four mandatory units, the qualification will be awarded with commendation.

### 4. Approved Centres

Centres wishing to offer examinations leading to RHS qualifications must be approved by RHS Qualifications.

Applications for approval should be sent to the Quality Assurance and Relationships Officer at the contact details in section 1.

### 5. Candidate Registration

RHS Approved centres should register candidates for examinations in the units of the qualification through the RHS Qualifications web portal.

Approved Centres undertake to obtain on behalf of their learners a Unique Learner Number (ULN), unless the learner chooses not to have one.

If centres supply an email address for candidates at the time of registration, candidates will be invited to open an account on the RHS Qualifications web portal, and will be able to view their examination history, their current registrations, and their results when available.

## **6. Reasonable Adjustments and Special Consideration**

RHS Qualifications is committed to ensuring fair assessment for all candidates, and will facilitate access to its qualifications through reasonable adjustments to assessment arrangements for candidates with an identified specific need. An example of a reasonable adjustment which could be made is the production of a modified examination paper for a candidate with a visual impairment.

Special consideration is given following the examination to candidates who are present for the examination but may have been disadvantaged by temporary illness, injury or adverse circumstances which arose at, or near, the time of examination.

Full guidance is provided in the document 'Guidance to Centres for Reasonable Adjustments and Special Consideration'. The document is available on the RHS website ([rhs.org.uk/qualifications](https://rhs.org.uk/qualifications)), the RHS Qualifications Approved Centre web portal, or can be obtained from RHS Qualifications.

Applications for reasonable adjustments or special consideration must be made by the Approved Centre on behalf of the candidate. Application must be made within specified timescales.

## **7. Enquiry about Results service**

The following service is available to candidates who have a query regarding their examination result:

### **Re-mark and Feedback**

Re-marking of the examination paper by an independent examiner.  
Feedback will be provided identifying areas of strength and weakness with constructive suggestions for improvement.

Candidates requesting a re-mark need to be aware that grades may go down as a result of the re-marking.

Applications for the 'Enquiry about Results Service' must be made through the Approved Centre where the candidate registered for the examination. This service will be available for 28 days from the date of release of the results to Approved Centres on the RHS web portal.

## **8. Examination Dates**

For a full list of examination dates please see the RHS Qualifications Examination Dates, this document is available on the Qualifications page on the RHS website and on the RHS web portal.

## 9. Fees

For a full list of fees please see the RHS Qualifications Fees Notice, this document is available on the Qualifications page on the RHS website and on the RHS web portal.

All fees are payable prior to confirmation of service or entry for the examination.

### Late Entries

RHS Qualifications publishes annually, and distributes to Approved Centres, the closing dates of entry for each examination for the following year.

Entries submitted after the published closing date will be subject to a late entry fee. The total fee charged for late entries is twice the standard examination fee for each unit

### Replacement Certificate (if lost, damaged or destroyed)

The fee for a replacement certificate can be found on the RHS Qualifications Fees Notice. Please send your request to the Qualifications Department.

### Re-mark & Feedback

The fee for a remark and feedback can be found on the RHS Qualifications Fees Notice.

If a re-mark results in an upgrade of the result, the fee paid will be refunded.

## 10 Unit Equivalents

Below is a table listing unit equivalences that have been granted for this qualification. Candidates who have been awarded a unit credit certificate for the previous unit number will not receive a unit certificate for the equivalent unit number.

Current Equivalent Unit Number	Previous Unit Number
H/505/2966	F/601/0993
M/505/2839	M/601/1007
D/505/2934	M/601/1038
J/505/8534	A/601/1043

## 11. Appeals Procedure

An Appeals procedure exists to conduct appeals lodged by candidates against decisions made by RHS Qualifications, concerning their examination performance, the granting of an award and/or the closure of their entry to an award on academic grounds.

The procedure is also followed in cases where there is irregularity or malpractice in the conduct of examinations and where RHS Qualifications has imposed a penalty on a candidate, tutor or invigilator, and the Centre wishes to appeal against this decision after results are published.

A copy of the procedure is available on the RHS Qualifications web portal and on the RHS website.



## **12. Policy on Malpractice and Maladministration**

Malpractice consists of those acts which undermine the integrity and validity of the assessment or examination, the certification of qualifications and/or damage the authority of those responsible for conducting the assessment, examination and certification.

RHS Qualifications does not tolerate actions or attempted actions of malpractice by learners or centres in connection with RHS qualifications. RHS Qualifications may impose penalties and/or sanctions on candidates or centres where incidents, or attempted incidents, of malpractice have been proven.

A copy of the full policy is available on the RHS Qualifications web portal and on the RHS website.

# Plant taxonomy, structure, and function

RHS reference number: R3101

Unit reference number: H/505/2966

Unit equivalent to F/601/0993

Unit guided learning hours: 32

Unit Level: Level 3

Unit purpose and aim(s): This unit will enable the learner to understand the principles of plant classification and nomenclature and to identify the role and function of higher plants' anatomical and morphological features. The unit also examines photosynthesis, respiration and movement of water through the plant, together with the regulation of plant growth.

Learning outcome The Learner will	Assessment criteria The learner can	Indicative column The learner should be able to
<p><b>1. Understand the Plant Kingdom and the taxonomic hierarchy.</b></p>	<p>1.1 Describe the major groups of the Plant Kingdom.</p>	<p>List the main groups within bryophytes, pteridophytes, gymnosperms and angiosperms.</p> <p>Describe and compare the structural and reproductive characteristics of: mosses, ferns, conifers and flowering plants in relation to their adaptation to terrestrial life.</p> <p><b>DETAILS OF ALTERNATION OF GENERATIONS AND HAPLOID/DIPLOID STRUCTURES ARE NOT REQUIRED.</b></p>
	<p>1.2 Describe features of plant classification and nomenclature relevant to horticulture.</p>	<p>State the hierarchy of botanical units and explain how and when they are used.</p> <p>To include: family, genus, species, subspecies, varietas, forma. To include <b>ONE NAMED</b> plant example for <b>EACH</b> of the above terms showing how it is written.</p> <p>Explain the meaning and use of the terms: cultivar, Group, trade designation (selling name), Plant Breeders' Rights, interspecific, intergeneric and graft hybrids, naming authority. To include <b>ONE NAMED</b> plant example for <b>EACH</b> of the above terms, showing how it is written.</p> <p>State the significance of the ICN (The International Code of Nomenclature for algae, fungi and plants) formerly ICBN (International Code of Botanical Nomenclature) and the ICNCP (International Code for Nomenclature for Cultivated Plants) in the naming of plants.</p> <p>Explain the reasons for name changes: reclassification (scientific research, new discovery),</p>

		changes in nomenclature (rule of priority), incorrect identification. Explain how plant names can indicate: plant origin, habitat, commemoration, colour, growth habit, leaf form. To include <b>TWO NAMED</b> plant examples for <b>EACH</b> .
<b>2. Understand the structure and function of plant tissues and organs in the life of the plant.</b>	2.1 Identify a range of plant tissues and describe their structure and function.	Identify and describe the structure and function of plant tissues, to include:  Simple tissues: parenchyma, collenchyma, sclerenchyma (fibres and sclereids), epidermis, meristem (cambium).  Complex tissues: xylem (vessels, tracheids, parenchyma, sclerenchyma fibres), phloem (sieve tube elements, companion cells, parenchyma, sclerenchyma fibres).  Secondary tissues: periderm (outer bark), phellem (cork), phellogen (cork cambium), phelloderm (secondary cortex), secondary phloem (inner bark) vascular cambium, secondary xylem, radial parenchyma (ray), annual rings.  Describe the process of secondary thickening in the stem of a woody perennial (e.g. <i>Tilia</i> ), from primary tissues to two years old.
	2.2 Identify and describe types of inflorescence.	Identify and describe types of inflorescence, to include: raceme ( <i>Digitalis</i> ), spike ( <i>Acanthus</i> ), umbel ( <i>Allium</i> ), corymb ( <i>Sambucus</i> ), cyme ( <i>Myosotis</i> ), panicle ( <i>Syringa</i> ), capitulum ( <i>Helianthus</i> ) and verticillaster ( <i>Phlomis</i> ).
	2.3 Describe plant adaptation for pollination.	Describe how the flowers/inflorescences of named plants are adapted for pollination by different named agents (to include: wind, bee, moth, butterfly, fly, bird), in relation to flower structure/shape, position, colour, scent, provision of food, flowering time, mimicry.  Draw and label diagrams to show the structure of grass and legume flowers and relate to mode of pollination.  State the meaning of cross pollination and self pollination. Explain the benefits of <b>EACH</b> using plant examples.

		State the means by which cross pollination is favoured: self incompatibility, flowering time, heterostyly, protandry/protogyny, dioecious plants.
	2.4 Describe fertilisation and the structure of fruits.	<p>Describe the process of fertilisation, to include: pollen grain, pollen tube, two male gametes, ovary, ovule, micropyle, ovum/egg cell/ female gamete, endosperm nucleus, zygote, double fertilisation.</p> <p>State the advantages and limitations of fertilisation resulting from cross pollination and self pollination.</p> <p>Describe the relevance of cross/self pollination to horticulture, to include: top fruit production (apple), vegetables (maize, cucumber), the use of cross/self pollination in the production of F1 hybrids.</p> <p>State the advantages of F1 hybrids.</p> <p><b>NO DETAILS OF THE GENETIC BASIS OF F1 HYBRIDS REQUIRED.</b></p> <p>Describe the development and structure of a true fruit: pericarp (exocarp/epicarp, mesocarp, endocarp).</p> <p>Recognise and describe the following fruit categories and their fruit examples: dry dehiscent (legume, capsule, follicle), dry indehiscent (nut, achene), succulent/fleshy (drupe, berry). Name <b>ONE</b> plant example for <b>EACH</b> fruit example.</p> <p>Describe what is meant by a false fruit. Draw and label a diagram of a pome from a named plant.</p>
<b>3. Understand photosynthesis, respiration, water/solute relations in the plant and their relevance to horticulture.</b>	3.1 Describe the process of photosynthesis.	<p>Describe the structure of the chloroplast to include: stroma, thylakoids, grana.</p> <p>Describe the process of photosynthesis: The interception of light by chlorophyll (wavelengths absorbed, PAR). The light dependent reaction (splitting of water to release oxygen and electrons, production of ATP and NADPH).</p> <p>The light independent reaction/dark reaction (carbon dioxide fixation, use of ATP, NADPH and electrons from the light reaction to produce sugar (glucose)).</p> <p>Significance of enzymes in photosynthesis: catalysts, temperature dependency.</p>

		<p>Specify differences in photosynthetic efficiency in: C3, C4 and CAM plants in outline using <b>NAMED</b> plant examples.</p> <p><b>NO DETAILS OF METABOLIC PATHWAYS REQUIRED.</b></p>
	3.2 Explain how the rate of photosynthesis can be manipulated.	<p>Describe how the following factors influence the rate of photosynthesis and explain how they can be manipulated:</p> <p>Light: light intensity (light compensation point, light saturation point); supplementary and replacement lighting; choice of lamp in relation to wavelength.</p> <p>Carbon dioxide: levels; ventilation; CO<sub>2</sub> enrichment methods.</p> <p>Temperature: temperature range, heating, shading, ventilation, damping down.</p> <p>Water and mineral nutrients: the need for adequate levels of irrigation and essential elements for chlorophyll formation (nitrogen, magnesium and iron).</p>
	3.3 Describe the processes of respiration.	<p>Structure of the mitochondrion to include: matrix, cristae.</p> <p>Describe aerobic respiration: Glycolysis (sugar (glucose) split to form pyruvate, production of ATP in the cytoplasm).</p> <p>Uptake of pyruvate and oxygen by the mitochondrion to produce CO<sub>2</sub>, H<sub>2</sub>O and ATP/heat.</p> <p>Energy output up to 38 ATP for <b>EACH</b> glucose molecule.</p> <p>Describe anaerobic respiration: Glycolysis (sugar (glucose) split to form pyruvate, production of ATP); pyruvate converted to ethanol (toxic) and CO<sub>2</sub> in the cytoplasm.</p> <p>Energy output 2 ATP for <b>EACH</b> glucose molecule. Describe examples of horticultural situations leading to anaerobic respiration.</p>
	3.4 Explain the movement of water and solutes through the plant.	<p>Explain how water and solutes enter, move through, and leave the plant. To include: apoplast, symplast, endodermis, Casparian strip, transpirational pull, root pressure, capillary action, guttation.</p>

		<p>Describe the significance of the following terms in relation to water movement in the plant: diffusion, osmosis, mass flow, capillarity, adhesion and cohesion.</p> <p>Explain how environmental factors affect the rate of transpiration: temperature, water availability, relative humidity, wind speed.</p> <p>Describe the uptake and distribution of mineral nutrients in the plant: nutrients from soil solution/ foliar feed, distribution in the xylem and phloem, active uptake against concentration gradient into cells by membrane carriers.</p> <p>Describe transport of sucrose in the phloem: mass flow hypothesis, phloem loading and unloading.</p> <p>Describe the concept of sources and sinks in relation to: plant organs; seasonal changes.</p>
	3.5 Explain the inter-relationships between photosynthesis, respiration and transpiration and describe their control in horticultural situations.	Describe how photosynthesis, respiration and transpiration are inter-related when optimising plant yield and/or quality in the following horticultural situations: outdoor planting; intensive glasshouse production; post harvest storage (manipulation of temperature and water loss, controlled and modified atmospheres, climacteric/non climacteric behaviour).
	3.6 Explain how plants are adapted to different habitats.	<p>Explain how plants are adapted for:</p> <p>low light levels (shade plants – to include differences in leaf surface area, chlorophyll density, palisade layer);</p> <p>anaerobic conditions (bog plants – to include aerenchyma, pneumatophores);</p> <p>reduced water supply (xerophytes - to include xeromorphic adaptations in <i>Pinus</i>).</p> <p>To include <b>ONE NAMED</b> plant example for <b>EACH</b> adaptation.</p>
<b>4. Understand the role of plant growth regulators in plant development and their relevance to horticulture.</b>	4.1 Describe the properties and key effects of endogenous plant growth regulators (PGRs) and their interactions.	<p>Describe the 5 major groups of endogenous PGRs to include the following properties and effects:</p> <p>Auxin e.g. IAA</p> <p>Properties: polar movement, root/shoot sensitivity, produced at shoot apex.</p> <p>Effects: cell elongation and enlargement, root development, apical dominance, fruit set and development.</p>

		<p>Gibberellin e.g. GA Properties: non-polar movement; produced in young expanding organs. Effects: promotes stem elongation; promotes seed germination and release from bud and seed dormancy; promotion of flowering and its link to vernalisation e.g. in biennials.</p> <p>Cytokinin e.g. zeatin Properties: non-polar movement, produced in meristems. Effects: promotion of cell division; shoot development; retardation of senescence.</p> <p>Abscisic acid Properties: non-polar movement; produced in leaves, stems, fruits and seeds; continuously broken down and remade. Effects: stomatal closure; promotion of dormancy in seeds.</p> <p>Ethene (ethylene) Properties: gas, produced in all cells; transported as a precursor ACC. Effects: senescence and ripening; abscission.</p> <p>Describe the interactions of PGRs in: cell division and differentiation (micropropagation); apical dominance; seed and bud dormancy.</p>
	<p>4.2 Describe the use of synthetic PGRs in horticultural situations.</p>	<p>Distinguish between synthetic and endogenous PGRs.</p> <p>State the advantages of synthetic PGRs.</p> <p>State what is meant by and give examples of: hormone mimics, growth retardants and growth inhibitors.</p> <p>Describe <b>TWO</b> synthetic PGRs used in different horticultural situations from the following list (purpose, application method, timing and amounts): IBA (4-indole –3-butyric acid) – adventitious rooting of ornamental cuttings; gibberellins – improved fruit set, quality and yield in top fruit, rhubarb and celery; Paclobutrazol – growth control in ornamental plant production; Trinexapac-ethyl – growth retardation in amenity grassland and managed turf; Ethene (ethylene) – sprout inhibition in potato storage.</p>

		<p><b>CHECK PGR AVAILABILITY WITH HEALTH AND SAFETY EXECUTIVE</b>  <a href="https://secure.pesticides.gov.uk/pestreg/prodsearch.asp">https://secure.pesticides.gov.uk/pestreg/prodsearch.asp</a> <b>OR IN CURRENT UK PESTICIDE GUIDE. DETAILS OF PGRs USAGE CAN BE FOUND IN UK PESTICIDE GUIDE AND PRODUCT LEAFLETS</b></p>
	4.3 Describe tropic plant movements.	Describe and explain the mechanism of: Phototropism and gravitropism (geotropism) in the root and shoot; thigmotropism (seismotropism).
	4.4 Describe how flowering is controlled in plants.	<p>State what is meant by the terms: photoperiodism, critical day length, day length categories (short day, long day, day neutral plants), 'florigen'.</p> <p>Name <b>ONE</b> plant example for <b>EACH</b> day length category.</p> <p>Describe the role of phytochrome in the photoperiodic response.</p> <p>State what is meant by the term vernalisation (cold treatment required for flowering)</p> <p>State the photoperiodic/vernalisation requirements (day length, temperature) for flowering in a <b>NAMED</b> horticultural crop: AYR <i>Chrysanthemum</i>, poinsettia (<i>Euphorbia pulcherrima</i>) <b>OR</b> strawberry (<i>Fragaria x annanassa</i>).</p> <p><b>NO PRODUCTION DETAILS REQUIRED</b></p>



# The root environment, plant nutrition and growing systems

RHS reference number: R3102

Unit reference number: M/505/2839

Unit equivalent to M/601/1007

Unit guided learning hours: 28

Unit Level: Level 3

Unit purpose and aim(s): This unit provides the underpinning knowledge required for the management of soils, growing media and plant nutrition and an understanding of organic growing systems.

Learning outcome The Learner will	Assessment criteria The learner can	Indicative column The learner should be able to
<p><b>1. Understand formation and properties of soils and other growing media.</b></p>	<p>1.1 Explain the process of soil formation and development.</p>	<p>Explain the natural processes of soil formation:</p> <p>types of parent rock (igneous, sedimentary &amp; metamorphic);</p> <p>weathering processes of parent rock (physical, chemical and biological), addition of organic matter;</p> <p>formation of soil types: alluvial, loess, sedentary;</p> <p>to include the influence of the underlying rock types (limestone/chalk, sandstone, granite);</p> <p>development and characteristics of main horizons: organic layer, A, E, B, C horizons, parent rock.</p> <p>Describe the following UK soil types and their effects on plant growth: iron pan podzol, brown earth, rendzina and gleys.</p>
	<p>1.2 Review the properties of soil organic matter, colloids and mineral components.</p>	<p>Define the terms anion, cation and buffering capacity, and explain the significance of cation exchange in soils and growing media.</p> <p>Organic matter: Describe the process of humification. Describe the properties of humus.</p> <p>Colloids: Particle size, origins of colloids, properties to include: cation exchange capacity and buffering capacity.</p>

		<p>Mineral components: Particle size (Soil survey of England &amp; Wales classification).</p> <p>Describe the properties of sand, silt &amp; clay, to include: surface charge, water holding ability, cation exchange capacity and buffering capacity.</p> <p>Describe how properties of these soil components influence soil temperature, nutrients, water holding ability and pH.</p>
	1.3 Compare a range of soil structures and describe their effects on plant growth and soil management.	<p>To include crumb, blocky, prismatic, platy, massive and structureless.</p> <p>Effects on plant growth: root penetration, plant stability, access to air, water and nutrients.</p> <p>State what is meant by the term cultivation window and explain how it relates to soil texture and structure.</p>
	1.4 Compare the physical and chemical properties on a range of substrates and constituents used for growing media.	<p>Substrates and constituents, to include peat, sand, loam, grit, perlite, vermiculite, polystyrene granules, peat alternatives (to include coir, composted green waste, composted bark), rockwool, leca.</p> <p>Properties to include: nutrient content, pH, water holding, cation exchange capacity, buffering capacity, stability, sterility.</p>
<b>2. Understand the relationship between plant growth, air and water in soils and other growing media.</b>	2.1 Describe the relationship between air and water content in the pore space of soils and growing media and how this influences their management.	<p>To include definitions of Air Filled Porosity, Saturation Point, Field Capacity, Temporary and Permanent Wilting Point, Soil Moisture Deficit and Available Water Content.</p> <p>Describe how soil texture, soil structure, organic matter content, irrigation and precipitation relate to the soil terms listed above.</p> <p>Compare irrigation techniques to maintain moisture in soils and growing media at appropriate levels, to include: ebb and flow, overhead sprinklers, porous pipe, drip irrigation and water balance sheet.</p> <p>Compare drainage techniques used to improve soil aeration to include: pipe drainage, mole drainage, swales and sand slitting.</p>

<p><b>3. Understand the role of living organisms in soil processes.</b></p>	<p>3.1 Summarise the biological activity that takes place in soils during the production of humus from organic matter.</p>	<p>Identify a range of organisms involved in humus production:</p> <p>macro-organisms: slugs, snails, earthworms, woodlice, spring tails, beetles, nematodes (eelworms).</p> <p>micro-organisms, bacteria, actinomycetes, saprophytic fungi.</p> <p>Identify the requirements for their activity: moisture, temperature, oxygen and pH.</p>
	<p>3.2 Describe the carbon and nitrogen cycles and summarise the role of nitrogen-fixing organisms.</p>	<p><b>Carbon cycle:</b> Describe the carbon cycle. Significance of carbon dioxide storage and release during soil cultivation, minimum tillage.</p> <p><b>Nitrogen cycle:</b> Describe the nitrogen cycle. Nitrogen fixation (rhizobia, azotobacter) Nitrifying (nitrosomonas, nitrobacter) and denitrifying bacteria.</p> <p><b>Phosphorus cycle:</b> Describe the Phosphorus cycle.</p> <p>Explain why knowledge of the carbon:nitrogen ratio is important when adding organic matter to the soil.</p>
	<p>3.3 Compare the roles of the rhizosphere and mycorrhizae in aiding healthy plant growth and treatment of root zones with added mycorrhizae.</p>	<p>State what is meant by the terms rhizosphere and mycorrhiza.</p> <p>Describe how endo and ecto mycorrhiza aid plant growth to include: moisture uptake, nutrient uptake (phosphates).</p> <p>Describe how the rhizosphere influences plant growth in the context of: nutrient uptake, moisture retention, defence against pathogens, allelopathy.</p>
<p><b>4. Understand the role of nutrients in plant growth.</b></p>	<p>4.1 Explain how specific nutrients affect plant growth.</p>	<p>Describe <b>ONE</b> role of <b>EACH</b> of the elements in plant metabolism: NPK nitrogen, potassium, phosphorus, sulphur, calcium, magnesium, iron and boron – expected level of detail: phosphorus required in ATP for energy transfer.</p> <p>State how the mobility of nutrients in soils (nitrogen, phosphorus and potassium) and in the plant (nitrogen, phosphorus, potassium, magnesium, calcium and iron) influence plant deficiency symptoms.</p>

		<p>Nitrogen: describe symptoms of deficiency and excess, and explain the causes to include: protein and chlorophyll synthesis, the effects on water uptake/osmosis and vegetative growth.</p> <p>Phosphorus: describe symptoms of deficiency and explain the causes, to include the effect on seedling growth.</p> <p>Potassium: describe symptoms of deficiency and excess, and explain the causes, to include: the effects on water uptake/osmosis, vegetative growth and reproductive phase.</p> <p>Magnesium: describe symptoms of deficiency and excess, and explain the causes, to include: chlorophyll synthesis, the effect on potassium availability and vegetative growth.</p> <p>Calcium: describe symptoms of deficiency (bitter pit, blossom end rot), excess and explain the causes, to include: vegetative growth, watering and liming.</p> <p>Iron: describe symptoms of deficiency and explain the causes to include protein/chlorophyll synthesis.</p> <p>Copper: state the horticultural situations where possible toxicity may occur (hydroculture, pesticide residue).</p>
	<p>4.2 Explain how various factors affect the availability of plant nutrients in soils and growing media.</p>	<p>Describe how <b>EACH</b> of the following factors affect the availability of plant nutrients, to include pH, soil texture, soil organisms, water content and leaching.</p> <p>Identify and compare <b>TWO</b> liming materials (neutralising value, fineness).</p> <p>Describe the use of fertilisers in various horticulturalsituations: open ground cultivation (mixed border, calcifuge), compost in seed trays and short term containers, long term container/nursery stock, lawns, hydroculture,</p> <p>Fertilisers: types (soluble, slow release, straight, compound, controlled release, chelates); application methods to include: fertigation, drip and foliar feeding; formulation (to include: granules, powders, prills, frits); purity of soluble fertilisers.</p>

<p><b>5. Understand organic growing.</b></p>	<p>5.1 Describe how organic status is certified in the UK.</p>	<p>State the various bodies that oversee organic status to include: IFOAM, EU, DEFRA and UK certification bodies (e.g. Soil Association, Organic Farmers &amp; Growers Ltd).</p> <p>Discuss the reasons for the need to regulate organic status.</p>
	<p>5.2 Discuss the benefits and limitations of certified organic status for growers.</p>	<p>Benefits: to include philosophy, marketing niche, product premium.</p> <p>Limitations: to include conversion to organic (time and cost required to convert), availability of approved inputs (propagation material, manures), growing in soil only (hydroculture and growing in containers may not be permitted).</p>
	<p>5.3 Identify management techniques available to the organic grower.</p>	<p>State the fundamental role of soil health and fertility in organic growing.</p> <p>Describe practices of soil management to include: maintaining humus levels, green manures, crop rotation, soil coverage and use of minimum cultivation.</p> <p>Compare the impacts on soil of organic and non-organic soil management techniques.</p> <p>Describe practices of nutrient management in organic growing and give the reasons for the following classification of fertiliser groups: 'acceptable/permitted', 'prior approval required' and 'never acceptable/prohibited'. Give <b>ONE NAMED</b> example in <b>EACH</b> group.</p> <p>Describe practices of organic weed, pest, and disease management. Weed management to include: hygiene, mulching, flame weeding, mechanical weeding, stale seedbed, green manuring.</p> <p>Pest management to include: biological and cultural control, chemical control, beneficial organisms.</p> <p>Disease management to include: hygiene, cultural control, chemical control.</p> <p>State the importance of varietal selection.</p> <p>Describe organic practices to control <b>ONE</b> annual &amp; <b>ONE</b> perennial weed, aphids, caterpillars, potato blight and apple scab.</p>

# The management of plant health

RHS reference number: R3103

Unit reference number: D/505/2934

Unit equivalent to M/601/1038

Unit guided learning hours: 24

Unit level: Level 3

Unit purpose and aim(s): This unit provides the underpinning knowledge of pest and disease life cycles and plant disorders. It provides knowledge of control methodology and sources of information on relevant legislation.

Learning outcome The Learner will	Assessment criteria The learner can	Indicative column The learner should be able to
<p><b>1. Know the characteristics of a range of pests, diseases and weeds of horticultural significance.</b></p>	<p>1.1 Describe symptoms and damage caused by a range of pests, diseases and weeds in specific horticultural situations.</p>	<p>To include:</p> <p><b>Pests:</b>            Codling moth            Two spotted spider mite            Peach potato aphid            Horse chestnut leaf mining moth            Vine weevil            Mealybug            Western flower thrips            Stem and bulb eelworm</p> <p><b>Diseases:</b>            Rose rust            Phytophthora ramorum and Phytophthora kernoviae            Clematis wilt            Cucumber mosaic virus            Fireblight            Potato leaf curl virus</p> <p><b>Weeds:</b>            couch            annual meadow grass            dock            Japanese Knotweed            bindweed            hairy bittercress</p>
	<p>1.2 Describe the life-cycles of a range of plant pests and diseases.</p>	<p>Describe the life-cycles of a range of plant pests and diseases to include survival, spread and/or transmission.</p> <p><b>Pests:</b>            Two spotted spider mite</p>

		<p>Vine weevil, Western flower thrips Stem and bulb eelworm</p> <p><b>Diseases</b> Rose rust Fireblight Phytophthora ramorum Cucumber Mosaic virus</p>
	1.3 Describe the biology of a range of weeds.	<p>Describe how the following weeds spread and/or maintain themselves in horticultural situations:</p> <p>Japanese knotweed bindweed hairy bittercress dock annual meadow grass</p>
<b>2. Review the control of pests, diseases and weeds in horticulture.</b>	2.1 State a range of appropriate methods for control of pests, diseases and weeds.	<p>To include: physical, cultural, chemical (including partial sterilisation of soils and other media), biological for each of the pests, diseases and weeds.</p> <p>Sources of information e.g. current UK Pesticides Guide.</p> <p>Define Integrated Pest Management.</p> <p>Review the use of Integrated Pest Management in horticultural situations:</p> <p>Explain what is meant by 'Economic Damage threshold'</p> <p>Appropriate selection of integrated control methods for pests, diseases and weeds listed in 1.1.</p>
	2.2 Explain how pests and diseases develop resistance to chemical control.	<p>Examples to include:</p> <p>Peach potato aphid Two spotted spider mite Rose rust Mice</p>
	2.3 Review the requirements for the safe use of chemicals used for plant protection.	<p>Be aware of the current legislation and codes of practice relating to the storage, handling and disposal of pesticides as it relates to professional users and domestic gardeners and allotment holders.</p>

		<p><a href="http://www.pesticides.gov.uk">www.pesticides.gov.uk</a> provides guidance for those using pesticides in gardens and allotments and the Code of Practice for Using Plant Protection Products applies to professional users.</p> <p><b>Storage:</b>  How to store chemicals  Assess risk (who or what might be harmed)  Control &amp; exposure (Personal Protective Equipment)  Record keeping  Criteria for security of store  Protect people/wildlife</p> <p><b>Handling:</b>  Methods of application (spraying/fog &amp; mist units)  Pesticide containers including Personal Protective Equipment  Transport of chemicals  Loading and unloading  Dilution of concentrates</p> <p><b>Disposal:</b>  How to reduce pesticide waste  Legal requirements and code of practice for disposing of pesticide and waste pesticide containers in professional and domestic situations.</p> <p>Identify the necessary certificates of competence which must be held in order to store and apply pesticides in a professional situation.</p> <p>Knowledge of and advantages of Environmental Management Schemes, to include: water courses wildlife and plants being protected; designated areas.</p>
	<p>2.4 Describe how biosecurity measures, are intended to prevent the distribution of pests, diseases and weeds.</p>	<p>To include prevention of the spread through trade and plant movement:</p> <p>Phytosanitary legislation  Plant passports (e.g. plants &amp; plant products which must be accompanied by a plant passport at all stages down to final retailer)  Codes of practice  Notifiable pests and diseases (e.g. Phytophthora ramorum, Colorado Beetle and Ash Dieback).</p> <p>Describe <b>THREE</b> biosecurity issues; case studies to include:  Japanese Knotweed  Colorado Beetle  Ash Dieback</p>



# Understanding applied plant propagation

RHS reference number: R3104

Unit reference number: J/505/8534

Unit equivalent to A/601/1043

Unit guided learning hours: 21

Unit level: Level 3

Unit purpose and aim(s): This unit provides an understanding of the relevance of plant anatomy and physiology to applied propagation by seed, spores and vegetative methods. The management of the associated equipment and aftercare is also covered.

Learning outcome The Learner will	Assessment criteria The learner can	Indicative column The learner should be able to
<p><b>1. Understand how knowledge of seed anatomy, physiology and environmental factors can be applied to propagate and conserve seeds successfully.</b></p>	<p>1.1 Explain the function of anatomical features in germinating seeds.</p>	<p>Explain the function of the following seed structures and their significance in germination: testa, cotyledon, endosperm, embryo, radicle, plumule, hypocotyl, epicotyl, hilum, micropyle, scutellum, coleoptile and coleorhiza.</p> <p>Distinguish between an endospermic <i>Zea mays</i> and non-endospermic (<i>Phaseolus vulgaris</i>) seed.</p>
	<p>1.2 Describe the physiological and environmental factors in seed dormancy.</p>	<p>State what is meant by 'primary' (innate) dormancy: dormancy present when seed is shed.</p> <p>State that 'secondary' (induced) dormancy develops from conditions that delay germination after primary dormancy is broken and will result in difficulties in subsequent germination.</p> <p>State a range of primary dormancy mechanisms, giving <b>ONE</b> plant example for <b>EACH</b> mechanism:            External imposed            seed coat:                interference with water uptake due to impermeable seed coat (<i>Lathyrus odoratus</i>);                Seed coat interferes with gas exchange (<i>Beta vulgaris</i>, <i>Paeonia delavayi</i>);            Mechanical restraint of the embryo/hard testa (<i>Prunus</i> spp).</p> <p>Fruit tissue inhibiting germination:            Fruit tissue contains germination inhibitors (e.g. tomato (<i>Solanum lycopersicum</i>)).</p> <p>Internal/embryo imposed:</p>

		<p>Seed remains dormant even though seed coat is removed. Internal germination inhibitors (<i>Fraxinus excelsior</i>) Embryo may be immature (<i>Ilex aquifolium</i>)</p> <p>State the role of abscisic acid, gibberellic acid and cytokinin in dormancy.</p>
	1.3 Describe methods used to overcome dormancy.	<p>State what is meant by the terms: 'stratification', 'scarification'.</p> <p>State what is meant by the term: 'after ripening' a process where warm temperature without moisture allows embryo to complete development. E.g. <i>Ilex aquifolium</i>, <i>Fraxinus excelsior</i>.</p> <p>Explain how dormancy is overcome by <b>EACH</b> of the following treatments: stratification (moist, warm and cold treatments), scarification (nicking, chipping and abrasion); soaking (hot or cold), chemical treatments (hormones, smoke and acids).</p> <p>Describe the methods of stratification and scarification giving a <b>NAMED</b> plant example suitable for <b>EACH</b> method, to include: (<i>Fraxinus excelsior</i>, <i>Lathyrus odoratus</i>).</p>
	1.4 Describe methods of seed treatments, preparation and sowing used to enhance germination.	<p>Describe a range of germination tests: percentage germination capacity, tetrazolium test, cutting test, floating test.</p> <p>Describe the purpose of a range of seed treatments to include: priming (<i>Allium porrum</i>), fluid sowing (<i>Pastinaca sativa</i>), pesticide treatment (<i>Zea mays</i>), coatings/pelleting (prills), (<i>Begonia Semperflorens Cultorum Group</i>).</p>
	1.5 Describe the significance of seed conservation and propagation for planting.	<p>State how plants can be conserved ex situ in seedbanks.</p> <p>Review the role of seedbanks in the conservation of UK native species.</p> <p>State the significance of 'provenance' in seed propagation for conservation purposes.</p> <p>State what is meant by the term hedgerow planting.</p> <p>Describe the production of <b>ONE NAMED</b> UK species for hedgerow planting, under <b>EACH</b> of the following headings:</p>

		<p>seed collection; seedbed preparation; method of sowing; aftercare; grading and lifting; transplanting.</p>
<p><b>2. Understand the relevance of anatomy, physiology and environmental factors to methods of vegetative propagation.</b></p>	<p>2.1 Describe how plant anatomy and plant physiology are relevant to vegetative propagation.</p>	<p>Define the term propagule.</p> <p>Explain the importance of the cambium, node, petiole, stem, leaf, root and axillary bud for <b>NAMED</b> methods of vegetative propagation.</p> <p>Explain why transpiration, respiration and photosynthesis are controlled to achieve successful vegetative propagation.</p>
	<p>2.2 Describe the preparation of a range of propagules.</p>	<p>Describe a range of propagation techniques to include: whip and tongue graft, T-Budding, chip budding, bulb scaling, scooping and scoring.</p>
	<p>2.3 Describe the propagation of plants by micro-propagation.</p>	<p>State what is meant by the terms 'micro-propagation' and 'totipotency'.</p> <p>Describe the processes of micro-propagation to include:</p> <ul style="list-style-type: none"> <li>plant material;</li> <li>facility and growth media;</li> <li>sterile techniques;</li> <li>weaning off.</li> </ul> <p>State the uses of micro-propagation in commercial horticulture, to include: propagation of difficult plants, rapid multiplication of stock, production of virus free stock.</p>
	<p>2.4 Describe the maintenance of stock plants used for the commercial production of stem cuttings.</p>	<p>Describe the annual maintenance of <b>ONE NAMED</b> stock plant (any named shrub) used for the production of stem cuttings, under <b>EACH</b> of the following headings:</p> <ul style="list-style-type: none"> <li>plant nutrition;</li> <li>pruning method and timing;</li> <li>pest and disease control;</li> <li>weed control.</li> </ul>
<p><b>3. Understand methods of propagation used in horticultural production.</b></p>	<p>3.1 Describe a range of propagation facilities.</p>	<p>Describe a range of propagation facilities and their use. To include: heated propagator, mist unit, fog unit, cold frame, low polythene tunnels, hot pipe callusing.</p>

	<p>3.2 Describe the production of a range of plants in the horticultural industry.</p>	<p>Describe the propagation of the shrub named in 2.4 under <b>EACH</b> of the following headings:</p> <p>cutting type and timing; propagation environment; weaning and potting.</p>
		<p>Describe the production of:</p> <p><b>ONE NAMED</b> grafted fruit tree, <b>OR ONE NAMED</b> chip-budded ornamental tree and <b>ONE NAMED</b> rose under <b>EACH</b> of the following headings:</p> <p>rootstock selection. grafting/budding technique (<b>IN OUTLINE ONLY</b>) field or container grown. aftercare timetable to saleable stock</p>