INCLUDING EXAMINERS COMMENTS

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R3101

PLANT TAXONOMY, STRUCTURE & FUNCTION

Level 3

Wednesday 13 February 2019

09:30 – 11:10

Written Examination

Candidate Number: ……

Candidate Name: ……

Centre Number/Name: ……..

IMPORTANT – Please read carefully before commencing:

i) The duration of this paper is **100** minutes;

ii) **ALL** questions should be attempted;

iii) **EACH** question carries **10 marks**;

iv) Write your answers legibly in the spaces provided. It is **NOT** necessary that all lined space is used in answering the questions;

v) Use **METRIC** measurements only;

vi) Use black or blue ink only. Pencil may be used for drawing purposes only;

vii) Where plant names are required, they should include genus, species and where appropriate, cultivar;

viii) Where a question requires a specific number of answers; only the first answers given that meet the question requirement will be accepted, regardless of the number of answers offered;

ix) Please note, when the word 'distinct' is used within a question, it means that the items have different characteristics or features.

Ofqual Unit Code M/505/2966

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ANSWER ALL QUESTIONS

MARKS

Q1 a) Describe the reproductive characteristics of conifers. **6**

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MARKS

b) State **FOUR** reproductive characteristics of flowering plants which differ from the conifer characteristics described in a). **4**

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MARKS

Q2 a) Give a **NAMED** plant example for **EACH** of the following inflorescences:

i) raceme; **1**
ii) panicle; **1**
iii) umbel; **1**
iv) corymb. **1**

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b) State **ONE** difference between the following inflorescences:

i) raceme and panicle; **1**
ii) umbel and corymb. **1**

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		MARKS
c)	Name **TWO** other types of inflorescence giving a **NAMED** plant example for **EACH.**	**4**

Total Mark

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MARKS

Q3 a) Label the diagram below to show **EACH** tissue where the following processes occur:

i) cell division; **2**
ii) starch storage; **3**
iii) water transport. **1**

Please see over/…..

MARKS

b) Describe the structure, including its cells, of **ONE** of the named tissues labelled in a). **4**

Total Mark

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MARKS

Q4 Plant names have several components providing a range of information.
For example, in the plant name *Viburnum tinus* 'Eve Price', the inverted commas of 'Eve Price' indicate that it is a *cultivar*. This has been produced 'artificially' and is not found in the wild.

For each of the terms listed below:

i) give a distinct **NAMED** plant example;
ii) explain each term in relation to the chosen plant example.

A. Group **3**

Plant example

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Explanation

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MARKS

B. Naming authority 3

Plant example

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Explanation

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C. Intergeneric hybrid 4

Plant example

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Explanation

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			MARKS
Q5	a)	Describe the process of anaerobic respiration.	**6**

Please see over/…..

MARKS

b) Describe how **ONE NAMED** plant is able to survive anaerobic conditions. **4**

Total Mark

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MARKS

Q6 State **FIVE** ways in which flowers are adapted for pollination by **EACH** of the following:

i) birds; **5**
ii) butterflies. **5**

i) Birds:

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MARKS

ii) Butterflies:

Total Mark

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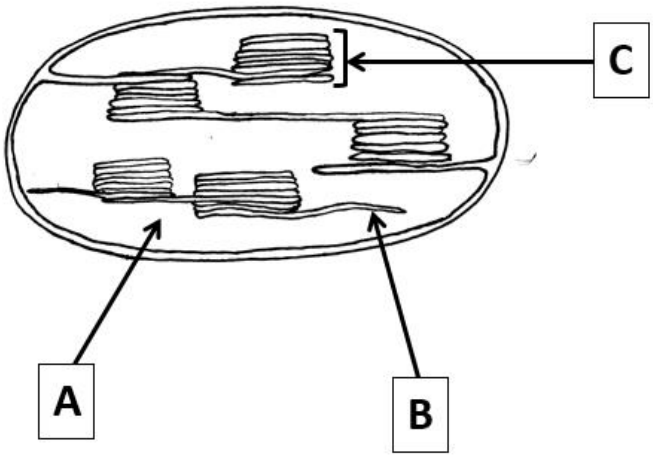
MARKS

Q7 a) Name the structures labelled **A, B** and **C** on the diagram of the chloroplast below:

Structure of a chloroplast



A:

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B:

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C:

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MARKS

b) Name the photosynthetic processes which take place on structures **A** and **B.** **2**

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c) Describe how light levels can be manipulated to optimise crop yield in a glasshouse situation. **5**

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MARKS

Q8 a) Define what is meant by the following terms, giving **ONE NAMED** plant example for **EACH,** by completing the table below:

Term	**Definition**	**Plant example**	
Short day plant			**2**
Long day plant			**2**
Day neutral plant			**2**

Please see over/…..

MARKS

b) Explain how gibberellin affects flowering when applied to plants. **3**

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c) State what is meant by the term ‘florigen’. **1**

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MARKS

Q9 a) State what is meant by the terms ‘source’ and ‘sink’ in relation to sucrose transport. **2**

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b) Describe how a bulb (e.g. *Narcissus*) can be both a ‘source’ and a ‘sink’. **5**

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MARKS

c) Name **THREE** substances, other than sucrose, that are transported in the phloem. **3**

Total Mark

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MARKS

Q10 a) State the meaning of **EACH** of the following terms:

i) self pollination; **1**
ii) cross pollination. **1**

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b) Describe the use of self and cross pollination in the production of F1 hybrids. **6**

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MARKS

c) State **TWO** benefits of F1 hybrids to commercial growers. **2**

Total Mark

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R3101

PLANT TAXONOMY, STRUCTURE & FUNCTION

Level 3

Wednesday 13 February 2019

Candidates Registered	**209**	**Total Candidates Passed**	**75%**
Candidates Entered	**163**	Passed with Commendation	35%
Candidates Absent/Withdrawn	37	Passed	40%
Candidates Deferred	7	Failed	25%

Senior Examiner's Comments

On the whole this paper was well answered with the majority of candidates attempting and completing all the questions. The following guidelines should be of help to future candidates.

1. Where named plant examples are asked for, full botanical names (genus and species) are required to achieve full marks. Common names will not be given a mark.

2. Use the command statements e.g. list or name (single words only), state (a few sentences), describe or explain (a fuller answer) together with the mark allocation, to judge the depth of the answer. Half marks are often allocated where the basic information given is correct but needs further qualification to gain the full mark.

3. Where a number of answers are specified in the question, the examiner will not select correct answers from a list e.g. if the question states 'State' **TWO** plant names', only the first two names given will be marked.

4. Labels on diagrams should be correctly positioned to avoid ambiguity and diagrams should be clearly drawn and annotated. No marks will be awarded for artistic merit.

5. Candidates should use unambiguous plant examples as reference sources from, for example, the RHS Find a Plant Service available on the RHS Website.

ANSWER ALL QUESTIONS

MARKS

Q1 a) Describe the reproductive characteristics of conifers. **6**

b) State **FOUR** reproductive characteristics of flowering plants which differ from the conifer characteristics described in a). **4**

Q1 a) This question asked for reproductive characteristics specific to conifers.

Not many candidates were able to provide six characteristics which distinguish conifers over and above having cones and 'naked' seed.

Examples of reproductive characteristics include: male cones/strobili producing pollen, containing the male gamete; female cones/strobili containing the ovum, (not an ovule or ovary), containing the female gamete; pollen dispersal by wind; single fertilisation; seed generally dispersed by wind.; female cone opens to receive pollen then closes once it is pollinated and it commonly takes two or more years from pollination to seed release. Seed is multicotyledonous.

b) Some candidates described conifers as having 'flowers' which, although this terminology is often used, it is not botanically correct.

Many candidates gave a lot of detail about flower structure in relation to pollination and pollination syndromes especially insect pollination, rather than focussing on the fundamental **differences** between angiosperms and conifers.
Almost all knew that angiosperms have an ovary which becomes a fruit enclosing the seed.

Many candidates stated that angiosperms could be dioecious and monoecious but failed to mention that most are hermaphrodite (in contrast to conifers).
Better candidates mentioned that angiosperms use a range of pollination vectors and seed dispersal mechanisms.
Mention of two male gametes and double fertilisation was also rewarded.

Food can be stored within endosperm tissue, unlike conifers or in one or two cotyledons of the seed, at maturity.

Only four characteristics were required so only the first four were taken.

Some candidates included characteristics which are common to both conifers and flowering plants which could not receive marks as the question asked for differences.

MARKS

Q2 a) Give a **NAMED** plant example for **EACH** of the following inflorescences:

i) raceme; **1**
ii) panicle; **1**
iii) umbel; **1**
iv) corymb. **1**

b) State **ONE** difference between the following inflorescences:

i) raceme and panicle; **1**
ii) umbel and corymb. **1**

c) Name **TWO** other types of inflorescence giving a **NAMED** plant example for **EACH.** **4**

Q2 a) Better candidates were able to give appropriate and well-known plant examples for the inflorescences with names correctly spelt for full marks. Examples included: raceme – *Digitalis purpurea,* panicle – *Syringa vulgaris*, umbel – *Daucus carota* and corymb – *Sambucus nigra.*

Achillea inflorescences are capitula (composite inflorescences) *not* corymbs although their arrangement is 'corymb-like' and could not be accepted for a plant example of a corymb.

b) Many candidates chose to submit a sketch to show the differences and some used words but key were the facts that the pedicel is branched in a panicle, unbranched in a raceme and that for a corymb, pedicels are alternately arranged along rachis (often to create a flat head) and for an umbel they are attached at a single point. Drawings clearly showing the differences were accepted and awarded the same marks as if in narrative explanation as long as they were clearly labelled.

i) Most candidates were able to distinguish between a raceme with flowers on an unbranched pedicel attached to a common peduncle/rachis and a panicle which has branching pedicels.

ii) Many candidates incorrectly stated that an umbel has pedicels of the same length whereas a corymb has pedicels of different lengths. Whilst this may be the case e.g. in Alliaceae, some umbels have pedicels of different lengths giving a flat-topped inflorescence similar in appearance to a corymb for example in Apiaceae. The difference is that the pedicels are joined to the peduncle/rachis at a single point in umbels whereas in corymbs they are attached at different points.

c) Most candidates could name two other types of inflorescence but not all were able to correctly name an appropriate plant example for each. Suitable examples included spike - *Plantago major;* cyme - *Stellaria media,* capitulum (or composite inflorescence) - *Bellis perennis; verticillaster* (often spelt incorrectly)-*Phlomis fruticosa.*

MARKS

Q3 a) Label the diagram below to show **EACH** tissue where the following processes occur:

i) cell division; **3**
ii) starch storage; **2**
iii) water transport. **1**

b) Describe the structure, including its cells, of **ONE** of the named tissues labelled in a). **4**

Q3 There was a technical issue with this question and all candidates were awarded aggregated marks based on their performance across the whole paper.

MARKS

Q4 Plant names have several components providing a range of information.
For example, in the plant name *Viburnum tinus* 'Eve Price', the inverted commas of 'Eve Price' indicate that it is a *cultivar*. This has been produced 'artificially' and is not found in the wild.

For each of the terms listed below:

i) give a distinct **NAMED** plant example;
ii) explain each term in relation to the chosen plant example.

A. Group **3**

B. Naming authority **3**

C. Intergeneric hybrid **4**

Q4 Sections A. Group and B. Naming Authority were very poorly answered by candidates indicating a lack of clear understanding of these nomenclatural terms. There was a greater understanding of what is meant by Intergeneric hybrid in section C. The 'RHS Plant Finder' provides reliable sources of information.

Group
Many candidates were unfamiliar with the nomenclatural term 'Group'.
A horticultural Group is a group of plants, species or hybrids, that share characteristics of horticultural significance (such as foliage colour) that are not otherwise recognised at the level of a botanical rank, such as botanical varietas (var.) or forma (f.). The word Group is always included e.g. *Achillea* The Pearl Group. Where cited with a cultivar name, it is enclosed in brackets, e.g. *Rhododendron* (Polar Bear Group)'Polar Bear'.
Very few candidates explained the term *'in relation to the chosen plant example'* as requested in the question, for example:
Actaea simplex (Atropurpureum Group) 'Brunette' belongs to a group of cultivars which have purple colouration in foliage, stems and flowers.
Cedrus atlantica (Glauca Group) 'Glauca Pendula' belongs to a group of cultivars with blue / glaucous foliage.

Naming Authority
Very few candidates knew that the naming authority (also known as the 'authority citation') refers to the person who first *published* this particular binomial name for this plant. This is written in abbreviated form at the end of the binomial. The most popular example was L. for Linnaeus as in *Amaranthus retroflexus* L. and Buddleja *davidii* L. The naming authority was sometimes confused with specific commemorative epithets e.g. *Berberis darwinii* and with the International Cultivar Registration Authority (ICRA).

Intergeneric hybrid
This section was well answered with most candidates stating that it is a sexual cross (hybridisation) between two plants from different genera and giving a correct written example. Extra marks were gained by giving the parental genera of the hybrid e.g. x *Fatshedera lizei i*s a hybrid between plants from the genera *Fatsia* (*F. japonica*) and Hedera (*H. helix*).

It is important to cite hybrid names that are currently accurate e.g. x *Cuprocyparis leylandii* which has superseded x *Cupressocyparis leylandii.*

MARKS

Q5 a) Describe the process of anaerobic respiration. **6**

b) Describe how **ONE NAMED** plant is able to survive anaerobic conditions. **4**

Q5 a) Part a) was generally well answered. Most candidates knew that anaerobic respiration takes place in the absence of oxygen and many scored highly by describing the process in detail and in a logical fashion. Glucose is split into two pyruvate molecules in the process of glycolysis, which are further broken down to release carbon dioxide and ethanol, two molecules of ATP are generated. The process takes place in the cytoplasm. Mention of the toxicity of ethanol and comparisons with aerobic respiration were not rewarded as only the **process** was asked for.

b) Full marks were given for a correctly named plant example and a description which was appropriate for that example. A wide range of named plant examples were provided by candidates including *Typha minima* and *Juncus effusus,* which both have aerenchyma tissue in their stems and roots, with large interconnecting air spaces that channel air and therefore oxygen down to the submerged roots from above the water. *Nymphaea alba* was credited with a description of floating leaves whose stomata are on the upper surface with aerenchyma tissue connecting leaves with roots. The term 'mangrove' could not be credited as it is a generic name for a group of plants inhabiting coastal intertidal zones; a named species was required, such as *Rhizophora mangle,* (which *does* ***not*** have pneumatophores but stilt roots with lenticels) or *Avicennia germinans* (which ***does*** have pneumatophores).

Marks were lost when candidates did not name a plant species and described general adaptations. Also, where incorrect adaptations were described – a common misconception being that *Gunnera manicata* produces pneumatophores.

MARKS

Q6 State **FIVE** ways in which flowers are adapted for pollination by **EACH** of the following:

i) birds; **5**
ii) butterflies. **5**

Q6 Most candidates demonstrated a reasonable understanding of these pollination syndromes. Named plant examples were not required.

i) Perching birds require a large robust flower with a strong, stiff pedicel to support the bird's weight, whereas hanging flowers with recurved petals allow hovering birds to access the copious nectar with a high sucrose content from the base of long floral tubes or spurs, whilst the exposed stamens deposit pollen on the bird's head. Bright red and orange colours are particularly attractive to birds.

ii) Butterflies need somewhere to land, often provided by the small, closely clustered flowers or florets of an inflorescence. They are attracted by brightly coloured pink and purple flowers.
Nectaries are often placed deeply within a tubular corolla or at the base of spurs, designed to match the length of this insect's long tongue. Some candidates gained points by relating the time of flowering to the time of year when the adult butterflies are flying, usually the summer.

Marks could not be awarded where broad statements which did not relate specifically to the named pollinator, e.g. 'flowers produce nectar'. This is also true for flowers pollinated by other pollinators such as bees. A misconception is that both bird and butterfly pollinated flowers are scented, which is not the case; birds do not have a sense of smell and butterflies do not have a good sense of smell but are attracted by colour and nectar guides.

Some candidates misread the question and confused pollination with seed and fruit dispersal.

MARKS

Q7 a) Name the structures labelled **A, B** and **C** on the diagram of the chloroplast below:

Structure of a chloroplast **1**
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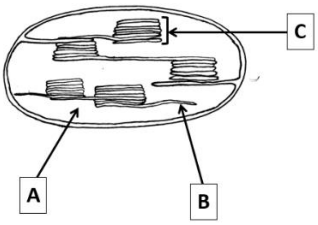
1



b) Name the photosynthetic processes which take place on structures **A** and **B.** **2**

c) Describe how light levels can be manipulated to optimise crop yield in a glasshouse situation. **5**

Q7 a) Most candidates correctly named A as the stroma, B as the thylakoid membrane (also known as the lamella) and C as the grana, but some could not correctly spell the names.

b) Again, most knew that the light independent reactions (also known as the Calvin Cycle), take place in the stroma whereas the light dependent reactions occur in the thylakoid membranes / lamellae.

c) Light compensation point and saturation point were rarely mentioned, but both are important considerations when deciding on whether additional, supplementary lighting is required in order to increase net photosynthesis and therefore increase crop yield. This is often the case in the winter months when the daylight hours are also shorter and light levels are below the light compensation point. The upper limit of light intensity is the light saturation point beyond which there is no net gain for photosynthesis so it is uneconomic to supply levels above this.

Most candidates focused on practical ways that light intensity could be increased, such as provision of supplementary lighting. Light of the correct wavelengths is an important consideration as the supplementary lighting must be PAR (Photosynthetically Active Radiation) and some candidates related this to the choice of suitable light sources such as LEDs and High-Pressure Sodium lamps.

Few noted that very high light intensity may cause damage to the photosynthetic apparatus and therefore shading with an appropriate method would be required in this situation.

Some candidates confused replacement lighting (in growth rooms e.g. using fluorescent lamps) with supplementary lighting used in glasshouses. Other candidates included details for photoperiodic lighting which were not credited.

Most answers lacked sufficient detail to be awarded the full five marks.

MARKS

Q8 a) Define what is meant by the following terms, giving **ONE NAMED** plant example for **EACH,** by completing the table below:

Term	Definition	Plant example	
Short day plant			**2**
Long day plant			**2**
Day neutral plant			**2**

b) Explain how gibberellin affects flowering when applied to plants. **3**

c) State what is meant by the term 'florigen'. **1**

Q8 a) Although photoperiodic control does not have to relate to flowering alone, all candidates answered with reference to this process.
A significant number of candidates could not correctly define the meaning of short- and long-day plants with regard to their *Critical Day Length.* There is the misconception that short day plants flower when there are more hours of darkness than hours of daylight in a 24-hour period, which is not necessarily correct. The flowering response is triggered in short day plants, e.g. *Euphorbia pulcherrima, Chrysanthemum morifolium,* when the daylight hours *are less than* the critical day length for that plant and in long day plants, e.g. *Lactuca sativa, Spinacia oleracea,* when the daylight hours *exceed* its critical day length. It should be noted that 'critical day length' varies between plant species and even between cultivars of some species, for example *Chrysanthemum*. Merely stating that plant flower in 'long days' or 'short days' could not be credited.
Most were aware that the flowering response of 'day neutral plants' is unaffected by day length, e.g. *Poa annua, Solanum lycopersicum.*

Candidates are reminded to avoid obscure plant examples that are difficult to verify – the photoperiodic requirements of some plants are still not known and different cultivars of some plants may have different photoperiodic requirements e.g. *Helianthus annuus* and Fragaria *x ananassa* in which case an appropriate cultivar should be named. *Petunia x hybrida can* be LDP, SDP or DNP depending on the cultivar.

b) This part was not well answered although most were able to make the point that gibberellins stimulate / trigger the flowering response in plants.
Very few stated that this is particularly important in biennials, where it overcomes the need for vernalisation to break flower bud dormancy and brings about 'bolting'. Gibberellins also stimulate the production of male flowers in *Cucurbita spp.*

Gibberellic acids can also be applied exogenously by growers to promote flowering in some long day plants in spring and summer e.g. for all year-round Azalea and *Cyclamen spp.* grown as pot plants, and to lengthen the stems of *Gerbera* flowers, although few candidates interpreted the question in this way.

c) The majority of candidates knew that 'florigen' is an (as yet unidentified) endogenous plant growth hormone/regulator which triggers/stimulates the flowering response in plants. Some described it as a protein or enzyme, although this has not yet been verified. Further description of how this substance reputedly works was not required for the single mark.

MARKS

Q9 a) State what is meant by the terms ‘source’ and ‘sink’ in relation to sucrose transport. **2**

b) Describe how a bulb (e.g. *Narcissus*) can be both a ‘source’ and a ‘sink’. **5**

c) Name **THREE** substances, other than sucrose, that are transported in the phloem. **3**

Q9 a) A source is a tissue or organ from which sucrose is *exported*. It is not necessarily where the sucrose is produced, although this was the common belief by many.

A sink is the tissue/organ where the sucrose is *transported to* and which therefore *receives* the sucrose. It is not necessarily stored here as it may be used immediately for growth.

b) Five marks were on offer here for a description of how the *bulb* (as an organ) can act as a source and also as a sink at different parts of its annual growth cycle. Some candidates did not focus on the bulb itself but considered the leaves of the plant as the source and flowers etc., (as well as the bulb), as the sink, rather than considering the *bulb* itself in both roles, which was required to gain full marks.

Successful candidates described the movement of sugars from the bulb at the end of the dormant period to fuel the growth of new roots and shoots; hence the bulb is acting as a source. During the growing season and when the leaves die back/senesce before dormancy, sugars are passed back to the bulb for storage and the bulb is therefore acting as a sink.

Very few referred to the tissue within the *fleshy scale leaves* inside the (where the sucrose is transported to and stored as starch) as a sink and from where the sucrose is transported to the meristems as a source.

An alternative interpretation by some candidates included a description of *how* the sugar is actually moved by pressure-flow, including active loading and transport of sucrose in the phloem using the pressure of water to drive the flow from source to sink and the unloading and recirculation of water at the sink.

c) Nearly all candidates were able to name three substances other than sucrose that are transported in the phloem. The majority named water, mineral nutrients and plant growth regulators and received three marks. Some were aware that amino acids also moved in the phloem. Some named three different endogenous plant growth regulators from auxin, gibberellin, cytokinin and abscisic acid (not ethylene), which also gained full marks.

It should be noted that not all mineral nutrients are successfully moved in the phloem, calcium, iron, manganese and copper, all immobile minerals, being notable exceptions.

MARKS

Q10 a) State the meaning of **EACH** of the following terms:

i) self pollination; **1**
ii) cross pollination. **1**

b) Describe the use of self and cross pollination in the production of F1 hybrids. **6**

c) State **TWO** benefits of F1 hybrids to commercial growers. **2**

Q10 a) A surprising number of candidates could not clearly state what is meant by

i) self-pollination. This occurs when pollen is transferred from an anther/stamen to a stigma on the *same plant*. This can occur within a single hermaphrodite flower, between different hermaphrodite flowers or between male and female flowers (in the case of a monoecious plant). It was not acceptable to say that the plant 'pollinates itself'.

ii) Nearly everyone correctly stated that cross pollination occurs when pollen is transferred from a flower on one plant to a flower on a different plant, usually of the same species. Better candidates stated that pollen is transferred from an anther/stamen to a stigma and that the other plant needs to be compatible.

b) The quality of candidates' answers to this part question varied greatly. The most common mistake was to describe hybridisation in general rather than focussing on F1 hybrids specifically.

The selection of two compatible parent plants with desired characteristics was usually stated. The parent plants then need to be self-pollinated (selfed) over several generations, rogueing out (removing plants with undesirable characteristics) unsuitable plants each time (this was rarely mentioned) until two pure breeding (homozygous) parent lines have been created.

The two pure parent lines are then brought together and cross pollinated, the resulting seed of which is the F1 hybrid seed. Some candidates transposed these two important stages in the process and therefore could not be awarded marks.

Better descriptions included methods of ensuring self-pollination such as isolating each parent line, bagging flowers to prevent unwanted pollination and to ensure cross pollination such as pollinating by hand, removal of stamens form the seed parent, and removal of the stigma from the pollen parent.

c) This was well answered, the majority stating 'hybrid vigour', including benefits to the grower of greater resistance to pest and disease, and larger fruits and flowers as one benefit and 'uniformity', including benefits such as the crop ripening at one time to aid mechanised harvesting, as the other. Retaining control of production by the breeder was also credited. Some mentioned that F1 hybrid seed is more expensive but this is not an advantage as it merely reflects the higher cost of production.