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INCLUDING EXAMINER COMMENTS

R3101

PLANT TAXONOMY, STRUCTURE & FUNCTION

Level 3

Wednesday 12 February 2020

09:30 – 11:10

Written Examination

Candidate Number: .....

Candidate Name: .....

Centre 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 can be used for drawing purposes only. Ensure that all diagrams are labelled accurately with the line touching the named object;
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

ANSWER ALL QUESTIONS

			MARKS
Q1	a)	Name the plant group within the plant kingdom to which ferns belong.	**1**
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	b)	Describe **FOUR** ways by which fern leaves (fronds) are adapted to enable ferns to live on land.	**8**
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MARKS

c) Name **ONE** example of a fern. **1**

Total Mark

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MARKS

Q2 Describe how flowers are adapted for pollination in a **NAMED** plant by the following agents:

i) bees **5**
ii) flies **5**

i)……

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MARKS

ii)

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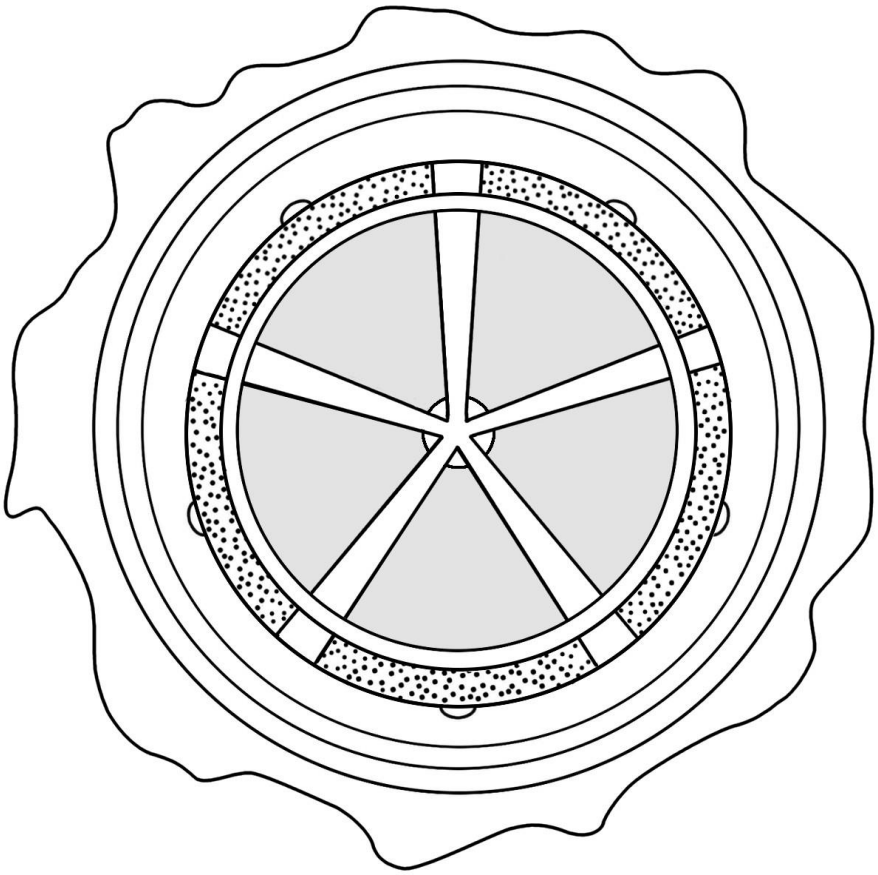
MARKS

Q3 a) Label the position of the following tissues on the diagram below:

i) primary xylem **1**
ii) phellem (cork) **1**
iii) phelloderm (secondary cortex) **1**
iv) secondary phloem **1**

Diagram of a Woody stem



b) Draw and label **TWO** annual rings on the diagram above. **1**

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MARKS

5

c) Describe the formation and structure of annual rings.

Total Mark

Please turn over/…..

MARKS

Q4 a) Define the term ‘tropism’. **2**

b) Explain the mechanism of gravitropism (geotropism) in the root. **5**

Please see over/…..

MARKS

c) State the significance of gravitropism in a germinating seed. **2**

d) Name **ONE** other type of tropism. **1**

Total Mark

Please turn over/…..

MARKS

Q5 Compare the light dependent and light independent reactions of photosynthesis by completing the table below:

	Starting materials	**Products**	**Site of reactions in chloroplast**
Light dependent reactions			
Light independent reactions			

5

5

Total Mark

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Turn over for next question

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MARKS

Q6 State the difference between the following terms giving a **NAMED** example for **EACH** term**:**

i) family and genus **4**
ii) subspecies and forma **6**

i)……

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ii) .....

MARKS

Total Mark

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MARKS

Q7 a) Explain why respiration is necessary for successful root growth. **2**

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b) Describe how outdoor planting conditions can affect root respiration. **8**

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MARKS

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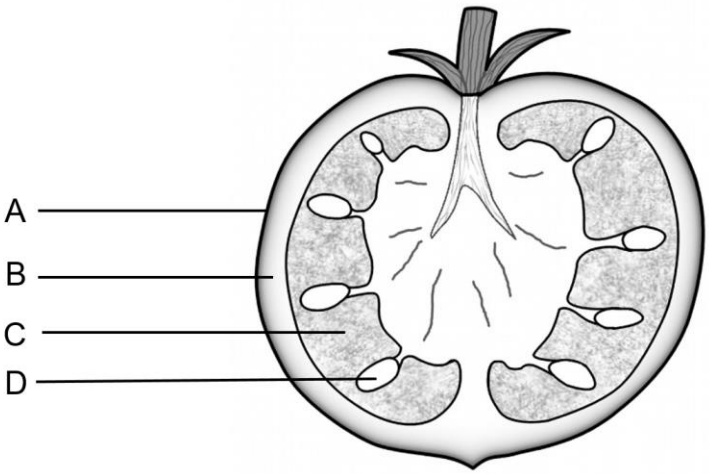
MARKS

Q8 a) Name the type of true fruit shown below giving a **NAMED** plant example.



Type of true fruit..... **1**

Name of plant example..... **1**

b) Name the structures labelled A-D in the diagram in a). **4**

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B.....

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C.....

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D.....

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MARKS

c) Describe the development of a true fruit following fertilisation. **4**

Total Mark

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MARKS

Q9 a) Explain how the following environmental factors affect transpiration from leaves:

i) increasing temperature **3**
ii) increasing windspeed **3**

i) .....

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MARKS

b) Describe how high transpiration rates lead to reduced crop yield and quality. **4**

Total Mark

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MARKS

Q10 a) Define the term ‘plant tissue’. **1**

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b) Describe the role of epidermis in a leaf under the following headings:

i) enables optimum photosynthesis **6**
ii) provides protection from pests and diseases **3**

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MARKS

ii)

Total Mark

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R3101

PLANT TAXONOMY, STRUCTURE & FUNCTION

Level 3

Wednesday 12 February 2020

Candidates Registered	**170**		**Total Candidates Passed**	**84**	**61%**
Candidates Entered	138	81%	Passed with Commendation	32	23%
Candidates Absent/Withdrawn	27	16%	Passed	52	38%
Candidates Deferred	5	3%	Failed	54	39%

General Comments:

The majority of candidates attempted and completed all the questions.

Where named plant examples are asked for, **full botanical names were required** to achieve full marks: genus, species and where appropriate variety, cultivar etc. needed to be written and spelt correctly. Where genus alone was given, all species in that genus need to show the characteristic asked for to gain any credit. **Common names were NOT accepted** and misspellings were penalised. Candidates needed to use unambiguous plant examples from sources such as the RHS Plant Finder and/or the RHS A-Z Encyclopaedia of Plants together with examples given in the syllabus and avoid obscure or difficult to verify plant examples, which risked being not credited.

Labels on diagrams needed to be carefully and correctly positioned to avoid ambiguity, not left hanging in mid-air. They needed to actually touch the appropriate part of the diagram. Annotations on diagrams were accepted as an alternative to description in the text as long as these were clear and answered the question. No marks were awarded for artistic merit or for unlabelled diagrams

Where a number of answers were specified in the question, e.g. 'List **TWO** plant names' or 'Describe **TWO** functions' **only the FIRST TWO answers** in a list were marked.

Candidates should take account of the command statements in the question e.g. 'list', 'describe', 'explain', together with the mark allocation, to judge the depth of the answer required. Extra information, even if it is accurate, does not gain extra marks.

			MARKS
Q1	***a)***	Name the plant group within the Plant Kingdom to which ferns belong	***1***
	b)	Describe **FOUR** ways in which fern leaves (fronds) are adapted to enable ferns to live on land	***8***
	c)	Name **ONE** example of a fern	***1***

Q1 ***a)*** Most candidates were able to name one of several alternatives including pteridophytes, pteridophyta, pterophyta, felicophyta.

b) Some candidates described roots, rhizomes etc rather than leaves so could not be awarded marks. Some gave general statements about leaves, which were not specific to ferns. Many candidates described the fern lifecycle, which was not asked for.

Better candidates described fern leaves (fronds) specifically, describing their structure and then going on to say how this adapts them to life on land. Some only gave details of structure and some described adaptations for shade rather than for terrestrial life.

Problems associated with life on land include:

Water loss – fern fronds have a waxy cuticle, stomata whose opening can be regulated and the presence of a vascular system to transport water from the roots to the aerial parts of the plant. Their spores are protected from desiccation in sori on the underside of leaves and hairs (ramentum) on the stems trap humidity.

Dispersal mechanism – ferns produce spores in sporangia on the underside of fronds and these are distributed by wind

Distribution of substances – minerals for the fronds are provided from the soil and sucrose exported from the frond via the vascular system

Few candidates commented on the arrangement of the fronds and the role of support tissues within to maximize light interception for photosynthesis.

Maximising photosynthesis – fern fronds have supporting tissue such as xylem and tracheids to keep the fronds upright and the shuttlecock arrangement of fronds in many ferns to maximise light interception

Competition with other plants – supporting tissues enable fronds to shade out other plants

c) Few candidates were able to give a full name and several incorrectly gave a cultivar name as a specific epithet *Polystichum congestum* which is *Polystichum setiferum* 'Congestum'. Correct examples include *Dryopteris filix-mas, Polystichum setiferum* and the most popular example given was *Dicksonia antarctica.*

Q2 *Describe how flowers are adapted for pollination in a* ***NAMED*** *plant by the following agents:*

i) bees **5**
ii) flies **5**

Q2 Candidates answers to this question varied in detail. Many gave general statements whereas the question asked for a description in a specific plant. Several did not give an appropriate named plant example and therefore lost marks.

i) Better candidates chose a plant example which was specific to bees e.g. *Digitalis purpurea* (the most popular choice) and members of Fabaceae such as *Lathyrus odorata.* Adaptations for bees specifically include the flower having a landing platform such as the keel petals in *Lathyrus*, nectaries and nectar deep in the flower, floral tubes with nectar guides as in *Digitalis*, anthers and stigma in specific positions to brush against the bee's body, any mechanism whereby the bee's weight opens the flower and a strong pedicel to support it. If scent is present it needs to be strong. Bees prefer blue, yellow, pink and white petals rather than red and can see in the UV part of the spectrum and are attracted by nectar guides on the corolla.

ii) Candidates again lost marks by not relating their descriptions to a specific plant. Examples of plants attracting carrion flies include *Stapelia gigantean* and members of Araceae family such as *Arum maculatum* and Dracunculus *vulgaris.* Adaptations in this group include a rotten meat colour and markings, a strong, putrid scent, sometimes with heat being produced by the spadix. Better candidates described trapping mechanisms such as hairs and the slippery surface of the spathe of *Arum.* Some confused the terms spathe and spadix.

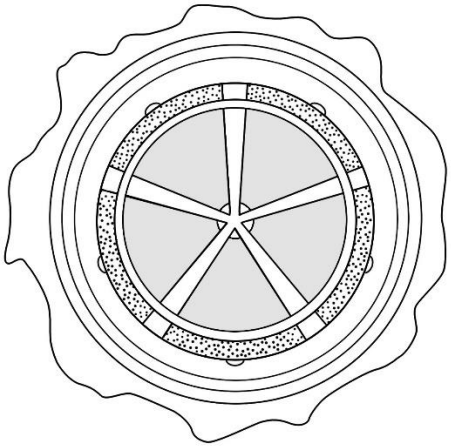
Other flies are attracted to members of Apiaceae family e.g. *Angelica sylvestris.* These small flowers tend to be pale in colour and massed in an umbel over which the flies crawl. They have open flower structures and a scent of urine.

MARKS

Q3 *a)* *Label the position of the following tissues on the diagram below:*

i)	*primary xylem*	**1**
ii)	*phellem (cork)*	**1**
iii)	*phelloderm (secondary cortex)*	**1**
iv)	*secondary phloem*	**1**

Diagram of a Woody stem



b) *Draw and label **TWO** annual rings on the diagram above.* ***2***

c) *Describe the formation and structure of annual rings.* ***4***

Q3 This question proved challenging for the majority of candidates. It is important that labelling is done carefully, ensuring that contact is made with either the outer edge or main part of the tissue to avoid ambiguity.

a) Most candidates were able to correctly label the diagram although some confused primary xylem with secondary xylem. The outermost tissue in the diagram is **(ii)** the phellem (cork). The ring of tissue inside the phellem is the phellogen (cork cambium) which generates **(iii)** the phelloderm (secondary cortex) to the inside. The primary xylem **(i)** is at the centre whilst the area shaded grey is the secondary xylem. The secondary phloem **(iv)** is the ring of tissue with speckled shading in the diagram.

b) Few candidates correctly drew two annual rings in the secondary xylem. Most drew three rings but were credited for labelling two of them. Where annual rings were drawn but not labelled no mark could be given.

c) Candidates were expected to describe both the formation ***and*** structural characteristics of annual rings and maximum marks could only be awarded where both were described.

A number of candidates described the process of secondary thickening rather than the formation of annual rings so could not be credited. Candidates need to describe both the formation and structure of annual rings so full marks could only be obtained if this was done. Better candidates described the production of secondary xylem towards the centre of the stem by the vascular cambium producing an annual ring each year. Xylem vessels in the spring (early/spring wood) have a faster growth, thinner walls and larger diameter than those produced later in the year (late/summer wood) and the contrast between these marks the division between rings.

Marks were also awarded for structural characteristics of xylem vessels and tracheids e.g. lignified walls, central lumen.

MARKS

Q4	*a)*	*Define the term 'tropism'.*	***2***
	b)	*Explain the mechanism of gravitropism (geotropism) in the root.*	***5***
	c)	*State the significance of gravitropism in a germinating seed.*	***2***
	d)	*Name **ONE** other type of tropism.*	***1***

a) Full marks were awarded for defining tropism as a 'directional growth in response to an external stimulus'. It was important to state that this is a growth movement (not just a movement) for full marks. Some provided an example of the stimulus e.g. light and this was accepted.

b) Most candidates understood that gravitropism is the downward growth of the root in response to gravity but few could describe the mechanism in sufficient detail for full marks. Better candidates were aware that auxin which is produced in the shoot tip collects on the downward side of a horizontal root where it inhibits cell expansion (unlike in the shoot where it stimulates it). This causes the root tip to grow down. Better candidates made reference to the role of starch-containing plastids (statoliths) within statocyte cells in the root cap acting as a gravity sensing mechanism and the associated accumulation of calcium which triggers the accumulation of auxin here.

Well annotated diagrams were also accepted where auxin concentration and direction of root growth in relation to gravity were clearly indicated.

Some candidates referred to the root being 'pulled' or 'drawn' down, which is incorrect.

c) Although most stated the requirement for the radicle to grow downwards (positive gravitropism) to anchor the seedling and for access to water and mineral nutrients, few mentioned the need for the plumule to grow upwards (negative gravitropism) to allow exposure to light for photosynthesis. Few candidates mentioned gravitropism in the shoots or explained why roots grow down (in search of water and minerals) and shoots grow up (in search of light).

c) Most candidates correctly named another tropism e.g. phototropism, thigmotropism.

MARKS

Q5 *Compare the light dependent and light independent reactions of photosynthesis by completing the table below:*

	Starting materials	***Products***	***Site of reactions in chloroplast***	
Light dependent reactions				***5***
Light independent reactions				***5***

Q5 This was a high-scoring question with most candidates able to name starting materials and products. However, a few also included the wrong materials in their lists of starting materials and products. Most candidates correctly stated that the light dependent reactions take place in the thylakoid membranes or grana whereas the light independent reactions occur in the stroma of the chloroplast. Those that did not correctly state where each set of reactions takes place could not score full marks.

Candidates who scored highly stated that the light dependent reactions take place in the thylakoid membranes or grana. The starting materials are water, ADP and NADP which produce oxygen, ATP and NADPH/$NADPH_2$.

The starting materials for the light independent reactions, which take place in the stroma of the chloroplast, are carbon dioxide, ATP and NADPH/$NADPH_2$ giving rise to glucose, ADP and NADP/$NADPH_2$.

		MARKS
Q6	*State the difference between the following terms giving a* ***NAMED*** *example for* ***EACH*** *term:*	
	i) family and genus	**4**
	ii) subspecies and forma	**6**

i) Candidates who scored highly provided a correctly spelt name for a family e.g. Asteraceae or Rosaceae and a genus e.g. *Helianthus* or *Rosa*. Candidates sometimes misspelt the word ending – aceae for family names. Where the binomial name of a plant species was written, credit could only be given to those who clearly indicated that the first part only is the name of the genus. The question asked candidates to 'state the difference' so answers should have been paired for full marks. For example, families are sub ranks of orders whereas genera are sub ranks of families. Or families contain a group of genera whereas genera contain a group of species. Some candidates correctly stated that plants within a genus have more characteristics in common than those within a family.

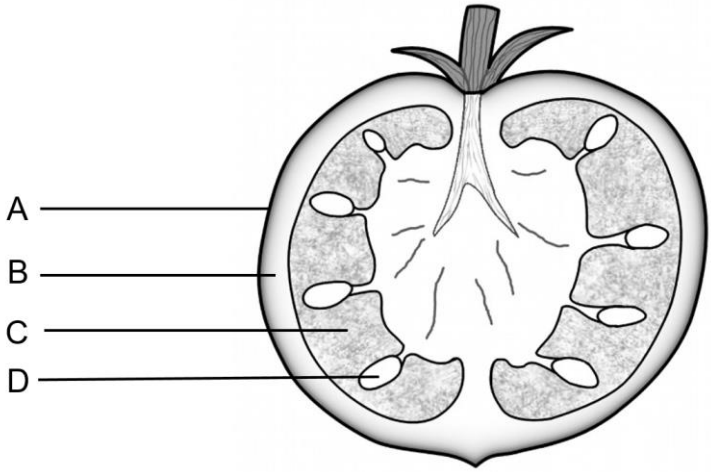
ii) Candidates were less familiar with subspecies and forma. Forma was sometimes confused with the intermediate category of varietas.
Subspecies show the widest variation from the original species. This is due to a wide geographical separation often on different continents leading to a long period of separate evolution in their different populations resulting in more genetic changes. Whereas forma are variations that occur over a much shorter period and within the same plant population and are not geographically isolated. The variation is slight and reflects one or two small mutations, which may occur within one generation.
When naming plant examples, particularly in nomenclature questions such as this, it is also important that plant names are spelt and written correctly according to accepted conventions/protocols, i.e. subspecies abbreviated as subsp., for example: *Hydrangea anomala* subsp**.** *petiolaris, Daucus carota* subsp. *sativus, Euphorbia characias* subsp. *wulfenii,* whereas forma is abbreviated as f., e.g. *Galanthus nivalis* f. *pleniflorus, Sambucus nigra* f. *porphyrophylla, Juncus effusus* f. *spiralis.*

			MARKS
Q7	*a)*	*Explain why respiration is necessary for successful root growth.*	***2***
	b)	*Describe how outdoor planting conditions can affect root respiration.*	***8***

Q7 a) Most candidates were able to state that respiration fuels root growth and the higher the rate of respiration the faster the growth. Better candidates explained that the process of respiration provides energy (in the form of ATP) for root growth by the breakdown of sugars, and expanded on this to explain that this provides energy for the production of new cells and that the faster the respiration rate, the greater the potential for root growth. For full marks, candidates had to explain that respiration provides energy from the breakdown of glucose for the production of new cells, for the uptake of minerals through active transport or for phloem loading for example.

b) Candidates who read the question carefully and related their answer to outdoor planting conditions and root respiration specifically were able to score highly on this part of the question. The environmental conditions which might arise in the soil include soil water content, oxygen availability, temperature and nutrients particularly phosphates which are required for root growth (phosphorus being a component of ATP and NADP).
Most candidates focussed on oxygen supply, which is affected by waterlogging, poor drainage and soil compaction and gave some account of anaerobic respiration which produces 2 ATPs per glucose compared with 38 ATPs for aerobic respiration. Many mentioned the toxic effects of ethanol although some confused this with ethylene. Better candidates mentioned the slower diffusion rate of oxygen through water than in air.
High soil temperatures can increase the rate of diffusion of oxygen in soils and increase the activity of respiratory enzymes thus increasing respiration and root growth. Conversely, lower temperatures reduce the rate of respiration, and very high temperatures denature respiratory enzymes reducing root growth.
Many candidates confused respiration with photosynthesis trying to link the effects of environmental factors such as temperature and wind on glucose production by photosynthesis, which might then affect supply to the root. This complicated the answer unnecessarily and marks could not be awarded here.

Q8 *a)* *Name the type of true fruit shown below giving a* ***NAMED*** *plant example.* **MARK**



Type of true fruit…….. **1**

Name of plant example…….…….…….... **1**

b) *Name the structures labelled A-D in the diagram in a).* **4**

c) *Describe the development of a true fruit following fertilisation.* **4**

Q8 *a)* Most candidates were able to correctly name the fruit as a berry and were able to give an example most commonly *Solanum lycopersicum.*

b) Most candidates labelled the diagram correctly: A being the exocarp/epicarp although some confused B, the mesocarp (the middle of the ovary wall) with C, the endocarp (the inner surface of the ovary. D was the seed.

c) Better candidates described the development of the fruit after fertilisation and did not give details of fertilisation itself. The exocarp/epicarp develops from the outer wall of the ovary,the mesocarp from the middle section and the endocarp from the inner wall. Together these form the pericarp. The seed develops from the ovule not the zygote as some stated. Other changes such as swelling of the ovary, development of sugar and aroma and colour changes were also credited. Those who mentioned the role of plant growth regulators auxin and ethylene in this process were also credited. The question asked for the development of a true fruit so candidates who mentioned the withering of other flower parts were rewarded as were comments on whether the pericarp becomes fleshy or dry, dehiscent or indehiscent.

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			MARKS
Q9	*a)*	*Explain how the following environmental factors affect transpiration from leaves:*	***MARKS***
		i) increasing temperature	**3**
		ii) increasing windspeed	**3**
	b)	*Describe how high transpiration rates lead to reduced crop yield and quality.*	***4***

Q9 *a)* **i)** Most candidates correctly stated that increasing temperature increases the transpiration rate. Better candidates went on to explain why this is the case. Increasing temperature increases the rate of evaporation from cell surfaces inside the leaf. The higher relative humidity inside the leaf increases the water vapour gradient between the inside and outside of the leaf therefore speeding up the rate of diffusion rate of diffusion of water vapour out of the leaf. Very high temperatures will however close the stomata and transpiration will cease. However, some candidates wrongly mentioned the effect of temperature on enzyme activity which is not relevant since transpiration is a passive process not involving enzymes.

ii) Most candidates correctly stated that increasing wind speed increases transpiration. Again, better candidates linked this to a reduction in the width of the boundary layer or reduced humidity at the leaf surface so increasing the water vapour gradient. Very high windspeeds lead to stomatal closure and cessation of transpiration.

b) This was not well answered several candidates confused transpiration with respiration or did not relate their answer to crop yield and / or quality and therefore did not answer the question.
Many candidates providing vague statements such as plants suffering from ‘high stress’ or ‘strain’ or just stating that crops will be ‘severely affected.’ Candidates who scored highly recognised that high transpiration rates lead to loss of turgor so cells do not expand fully and plants and plant parts will be smaller so yields lower. Photosynthesis will be reduced through stomatal closure reducing CO_2 uptake and through leaves wilting reducing light interception, leading to less photosynthesis and growth. Loss of turgor will affect quality through wilting and water loss will reduce saleable weight. Quality can be reduced when leaves, petals or fruit are shed.
Some described adaptations to conserve moisture but this was not asked for and others incorrectly thought that if stomata close, respiration is reduced so growth will be reduced.

			MARKS
Q10	*a)*	*Define the term 'plant tissue'.*	***1***
		Describe the role of epidermis in a leaf under the following headings:	
	b)	*i) enables optimum photosynthesis*	**6**
		ii) provides protection from pests and diseases	**4**

Q10 *a)* Most candidates were able to define a tissue as 'a group of cells fulfilling a specific function'. Several candidates described functions of tissue (packing, transport etc.) or named tissues instead of defining the term and gained no marks.

b) **i)** Candidates who scored highly mentioned a specific feature of the epidermis then related their answer to photosynthesis describing its role. For example, the epidermis is one cell thick (not one layer thick) and transparent and therefore allows light through to the photosynthetic tissue below. Stomata enable gas exchange enabling absorption of CO_2 and release of O_2 and this is controlled by guard cells. The waxy cuticle and lack of air spaces between the cells reduces water loss thereby preventing wilting and allowing maximum light interception.
ii) Better candidates specified the way in which the epidermal features protect the leaf from pest and disease e.g. the waxy cuticle prevents pathogens entering and sheds water so fungal spores cannot germinate. The tightly packed cells with no air spaces between also prevent entry of pathogens. Similarly, glands producing toxins, leaf prickles or stinging hairs deter herbivores.

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