RHS LEVEL 3 DIPLOMA IN HORTICULTURE
WRITTEN EXAMINATION

2:00pm Thursday 9th July 2009

MODULE G

Genetics, Plant Breeding & Systematic Botany
Plant Physiology II

Section A – Short Answer Questions

Candidate Number:……

Candidate Name:……

Centre Number/Name:……..

IMPORTANT – Please read carefully before commencing.

i) The duration of the papers in Module **G** is **2 hours**.
ii) Answer **ALL** questions in Section **A**.
iii) **ALL** questions in Section **A** carry equal marks.
iv) Write your answers legibly in the spaces provided.
v) Use metric measurements **ONLY**.
vi) Where plant names are required, they should include genus, species and where appropriate cultivar.

Please turn over/…..

ANSWER ALL QUESTIONS

MARKS

Q1 State **TWO** advantages and **TWO** limitations of self pollination. **2**

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Q2 State the principal reason for conducting a ‘back cross’ in plant breeding. **2**

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Q3 State **TWO** advantages and **TWO** limitations of using a floral key in the identification of plants. **2**

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Q4 Explain, how plants are classified according to photoperiodic response. **2**

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Please see over/…..

ANSWER ALL QUESTIONS

MARKS

Q5 State **FOUR** possible causes of physical dormancy in seeds. **2**

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Q6 State the **TWO** main components of crop growth rate (C). **2**

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Q7 State the principal effect on photosynthetic efficiency of **EACH** of the following:

i) crop canopy;
ii) spatial arrangement. **2**

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Please turn over/…..

ANSWER ALL QUESTIONS

MARKS

Q8 State **FOUR** reasons why monoculture is adopted with horticultural crops. **2**

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Q9 State the principal function within plants of **EACH** of the following:

i) abscisic acid (ABA);
ii) gibberellin. **2**

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Q10 Define the term apical dominance. State **ONE** advantage of apical dominance to the horticulturist. **2**

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MODULE G

Genetics, Plant Breeding & Systematic Botany
Plant Physiology II

Sections B & C - Structured Questions

IMPORTANT – Please read carefully before commencing.

i) The duration of the papers in Module **G** is **2 hours**.
ii) Answer **ONE** question from Section **B** and **TWO** questions from Section **C**.
iii) **ALL** questions carry equal marks.
iv) Write your answers legibly in the answer booklets provided.
v) Use metric measurements **ONLY**.
vi) Where plant names are required, they should include genus, species and where appropriate cultivar.

Please turn over/…..

Section B – Genetics, Plant Breeding & Systematic Botany

Answer ONE question only from this section

MARKS

Q11 a) Explain how errors in replication can occur in **BOTH** mitosis and meiosis. **8**

b) Record the genotype and phenotype generation that would result from selfing this F^1 hybrid.

W = White flowers
w = Red flowers
H = Hairy leaves
h = Non hairy leaves **8**

c) Explain why double recessive plants may be of interest to the plant breeder. **4**

Q12 Describe and compare, **TWO** different plant breeding methods under **EACH** of the following headings:

i) methods used to achieve a new hybrid; **5**
ii) accuracy of the predictions; **5**
iii) limitations of each method; **5**
iv) success rate of each method. **5**

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Please see over/…..

Section C – Plant Physiology II

Answer TWO questions from this section

MARKS

Q13 a) Define **EACH** of the following:

i) physiological age; **5**
ii) photoperiodic response. **5**

b) Differentiate between growth and development. **5**

c) Explain why 'minimal leaf number' is a critical stage in plant growth. **5**

Q14 a) Explain, with reference to a **NAMED** crop, how respiration is manipulated to achieve maximum shelf life using **EACH** of the following headings:

i) pre-harvest conditions; **6**
ii) post-harvest conditions. **8**

b) Describe the processes in the plant that occur when the crop deteriorates under unsuitable storage conditions. **6**

Q15 a) Describe in respect to phytochrome, **EACH** of the following:

i) forms of phytochrome; **4**
ii) the phytochrome reaction. **6**

b) Explain the effect of the quality, intensity and duration of light on the phytochrome reaction. **6**

c) Describe in detail, **ONE** plant process involving phytochrome. **4**

Q16 a) Explain the relationship between crop canopy and spatial arrangement on yield. **10**

b) Explain how crop spacing and density influences the part of the plant to be harvested. **10**

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The Royal Horticultural Society, Wisley, Woking, Surrey, GU23 6QB.

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WRITTEN EXAMINATION

Thursday 9th July 2009

MODULE G

Genetics, Plant Breeding & Systematic Botany
Plant Physiology II

Candidates Registered	**60**		**Total Candidates Passed**	26	47.27%
Candidates Entered	55	91.67%	Passed with Commendation	1	1.82%
Candidates Absent	4	6.67%	Passed	25	45.45%
Candidates Deferred	1	1.66%	Failed	29	52.73%
Candidates Withdrawn	0				

Section A – Short Answer Questions

Q1 State **TWO** advantages and **TWO** limitations of self pollination.

The aim of this question is to demonstrate an appreciation of the advantages and disadvantages of self pollination.
High marks were awarded for citing two advantages such as: to maintain pure breeding status, and maintaining of the distinctive characteristics of the plant; and two disadvantages i.e. inbreeding and its inherent problems, also that, the plant is less likely to adapt to environmental change.

Q2 State the principal reason for conducting a 'back cross' in plant breeding.

The question is asking candidates to ascertain the principal reason for conducting a back cross; not a description of the technique. High marks were awarded for citing that the principal reason for conducting a back cross is to maintain, add or enhance features previously selected from the parent, which may have been lost through the breeding programme.

Q3 State **TWO** advantages and **TWO** limitations of using a floral key in the identification of plants.

The aim of this question is to demonstrate an appreciation of the value of floral keys to plant identification. High marks were awarded for citing two advantages such as: an exacting method of ID based on botanical features and that a vegetative key is available if the plants are not in flower. Additional marks were awarded for citing two disadvantages such as: a detailed knowledge of botany is required and that it is a time consuming process.

Q4 Explain, how plants are classified according to photoperiodic response.

The aim of this question is to elicit an explanation of the mechanism of the photoperiodic response in plants. High marks were obtained for a clear description of the 3 main response groups, including details of response periods and individual plants.

Q5 State **FOUR** possible causes of physical dormancy in seeds.

The aim of this question is to demonstrate an appreciation of the phenomenon of physical dormancy in seeds.

There was much confusion in the answers. Candidates cited various dormancy types in the answer. High marks were obtained for answers that included: hardseededness, immature embryos, the presence of inhibitors within the seed covering structure, presence of a hard, woody fruit wall.

Q6 State the **TWO** main components of crop growth rate (C).

The aim of this question is to ascertain if candidates were able to cite the two main components of crop growth rate.
High marks were obtained for answers that included statements on Leaf Area Index and Net Assimilation Rate.

Q7 State the principal effect on photosynthetic efficiency of **EACH** of the following:

i) crop canopy;
ii) spatial arrangement.

The question asked candidates to explore the relationship between photosynthetic efficiency and the crop canopy and spatial arrangement of the crop.
High marks were obtained for answers that stated that the percentage of cover of leaves at any given time is related to the age and growth rate of the plant. In addition, a statement of how the arrangement of the leaves on the plant and/or the plants on the ground, affected the photosynthetic efficiency, was awarded high marks.

Q8 State **FOUR** reasons why monoculture is adopted with horticultural crops.

The question asks to ascertain the advantages of monoculture to horticultural cropping. High marks were awarded to answers that stated reasons such as ; the plant nutrition is identical for all plants, pest and disease control can be carefully and accurately managed, harvesting of the crop is simplified, often once-over harvested; crop rotation is efficiently managed.

Q9 State the principal function within plants of **EACH** of the following:

i) abscisic acid (ABA);
ii) gibberellin.

The aim of this question is to ascertain the principal function of these two plant growth regulators. High marks were obtained for answers that stated that ABA's principal function is in water regulation and stomatal closure, whilst that of GA is cell division and cell elongation.

Q10 Define the term apical dominance. State **ONE** advantage of apical dominance to the horticulturist.

The aim of this question is to elicit a succinct definition for apical dominance and an example of how the phenomenon is advantageous in horticulture. High marks were awarded for a definition which stated that it is the term used for the process in which the apical bud prevents the growth of the lateral buds below it and that it is mediated by auxins. Advantages to horticulture include the production of single stem plants such as standard trees or the converse, bushy plants.

Sections B & C – Structured Questions

Section B - Genetics, Plant Breeding & Systematic Botany

Q11 a) Explain how errors in replication can occur in **BOTH** mitosis and meiosis.

b) Record the genotype and phenotype generation that would result from selfing this F^1 hybrid.

W = White flowers
w = Red flowers
H = Hairy leaves
h = Non hairy leaves

c) Explain why double recessive plants may be of interest to the plant breeder.

The aims of the question are to explore candidate's knowledge and understanding of the sources of genetic variation that could occur during mitosis and meiosis, to determine the genotype and phenotype of the F_2 generation resulting from selfing an F_1 hybrid with known genotype for two characteristics (dihybrid inheritance) and to appreciate the practical value to the plant breeder of expression of double recessive genes.

a) Candidates who understood the structure of DNA and how errors of addition, deletion, substitution of nucleotide bases could occur in replication of DNA, as well as inversion of sections of the code, during interphase prior to both mitosis and meiosis gained some marks.
Better candidates were able to discuss possible errors in chromatid separation during mitosis, leading to chromosome duplication (polyploidy) or unequal numbers of chromosomes in daughter cells.
Other examples of errors in DNA replication relating to whole or part chromosomes would be translocation where large chromosome fragments or whole chromosomes could be lost or rejoin to a different chromosome.
Errors could also occur in prophase1 of meiosis during crossing over of chromatids with unequal exchange of DNA, with unequal allocation of homologous chromosomes to daughter cells in Meiosis 1 and of chromatids in Meiosis 2, and non formation of the spindle in both stages of meiosis leading to production of polyploid gametes.

Candidates were rewarded for the explanation of how errors in replication could occur but not for detailed description of mitosis and meiosis or methods for inducing mutations.

b) Most candidates understood that this part of the question related to dihybrid inheritance of the two named characteristics and were able to record the correct ratio of phenotypes:
9 white flowered with hairy leaves;
3 white flowered with non hairy leaves;
3 red flowered with hairy leaves;
1 red flowered with non hairy leaves.

It was expected that candidates would be able to produce a Punnet square

to demonstrate the potential gametes formed by the F_1 plant, WH, Wh, wH and wh and the possible genotype combinations in the F_2 generation.

Genotype of F_1 is WwHh
Punnet Square to show possible genotypes of F_2

Gametes	WH	Wh	wH	wh
WH	WWHH	WWHh	WwHH	WwHh
Wh	WWHh	WWhh	WwHh	Wwhh
wH	WwHH	WwHh	wwHH	wwHh
wh	WwHh	Wwhh	wwHh	wwhh

Many candidates used coloured pens or symbols to assist their interpretation of genotype to phenotype.

c) Incidence of the double recessive, example wwhh above, is very low, 1 in 16 for dihybrid inheritance, thus phenotypic characteristics would not be observed frequently. This could be a source of potentially valuable characteristics to the plant breeder such as flower colour, shape, disease resistance or any other commercially valuable feature. Double recessive plants are also of use in test crosses.

Candidates should note the allocation of marks to different sections of the question and allocate their time accordingly.

Q12 Describe and compare, **TWO** different plant breeding methods under **EACH** of the following headings:

i) methods used to achieve a new hybrid;
ii) accuracy of the predictions;
iii) limitations of each method;
iv) success rate of each method.

The aims of the question are to examine candidate's knowledge of two named plant breeding techniques for production of new hybrids including the technical methodology, predictions of genetic success, the limitations in terms of resources and the success in producing and releasing a new hybrid.

This question enabled better candidates to discuss the relative merits of two appropriate methods of producing new plant hybrids such as the production of F_1 hybrids, line selection or genetic modification. Some candidates did not select relevant breeding methods or did not compare different plant breeding methods.
Marks were given for technical accuracy of the description of the breeding methods chosen, pertinent discussion of prediction of success in relation to chosen characteristics, limitations of the breeding method in terms of plant material, technical expertise and facilities required and informed comment on the success rate of each method with appropriate plant examples.
Marks were also allocated for comparison between chosen methods for each part of the question.

Section C – Plant Physiology II

Q13 a) Define **EACH** of the following:

i) physiological age;
ii) photoperiodic response.

b) Differentiate between growth and development.

c) Explain why 'minimal leaf number' is a critical stage in plant growth.

AIMS
The aims of the question were for candidates to distinguish between growth and development, to define two terms associated with growth and development and to explain why ' minimal leaf number' is an important stage in development and a plant's capacity for responding to photoperiod in relation to flowering.

COMMENTS
Physiological age was well understood by the majority of candidates who were also able to contrast it with chronological age. However, very few expanded their answer to the implications of physiological age for horticultural operations.
Growth and development were not distinguished very well. Many candidates considered growth to be an increase in size, often stating it to be due to the uptake of water into the cells of the plant. Very few understood it to be an increase in dry weight due to photosynthesis.
Development was usually described in relation to differentiation or juvenility/maturity but not both.
Many candidates were unaware of the concept of 'minimum leaf number' but those who had knowledge of this usually produced a good answer.

Q14 a) Explain, with reference to a **NAMED** crop, how respiration is manipulated to achieve maximum shelf life using **EACH** of the following headings:

i) pre-harvest conditions;
ii) post-harvest conditions.

b) Describe the processes in the plant that occur when the crop deteriorates under unsuitable storage conditions.

AIMS
The aims of the question were for candidates to describe how respiration is controlled to provide optimal storage conditions for a crop and to describe the processes that would occur in unsuitable storage conditions to reduce the marketable quality of the crop.

COMMENTS
Most answers referred to the storage of apples. The manipulation of pre-harvest conditions was not usually done well, most candidates including much irrelevant material instead of focusing on respiration. Post-harvest

conditions, on the other hand, were understood much better although detail was often scanty. Although credit was given for any process that occurs in the crop under unsuitable storage conditions, such a process must be one that leads to deterioration. Ripening on its own, without qualification, is not a deterioration. Very few answers referred to the possible development of anaerobic respiration in the crop.

Q15 a) Describe in respect to phytochrome, **EACH** of the following:

i) forms of phytochrome;
ii) the phytochrome reaction.

b) Explain the effect of the quality, intensity and duration of light on the phytochrome reaction.

c) Describe in detail, **ONE** plant process involving phytochrome.

AIMS
The aims of the question were to elicit full details of the phytochrome reaction in plants and one example of a plant process that is controlled by the phytochrome reaction.

COMMENTS
Answers to this question were very variable. The interconversion of the red and far-red forms of phytochrome was usually known but there were some common omissions/misconceptions:

1) Under natural conditions ie. daylight, Pr is converted to Pfr, but most candidates referred to the plant being illuminated by red light.
2) The absorption spectra of the two forms have maxima at 660nm and 730nm, most considered that this was the only wavelength absorbed.
3) Light intensity needed is around 20 lux, intensity was usually omitted in answers.

The description of one plant process usually referred to flowering but answers lacked detail and reference to a horticultural context.

Q16 a) Explain the relationship between crop canopy and spatial arrangement on yield.

b) Explain how crop spacing and density influences the part of the plant to be harvested.

AIM
The aim of this question was to elicit from the candidates their understanding of how plant architecture and crop spacing impacts on yield.

COMMENTS
This was a very unpopular question. Most answers referred to spacing, competition, overlapping canopies and their effects on the size of individual units of the crop. The interaction with yield was not usually mentioned and technical terms like leaf area index were not often used.

RECOMMENDATIONS FOR QUESTIONS 13 – 16

1) Candidates should endeavour to keep their answers wholly relevant to the question and include appropriate detail.

2) Candidates should refer to the horticultural context whenever appropriate. An example would be the production of brassicas: brussel sprouts.