Royal Horticultural Society

RHS LEVEL 3 DIPLOMA IN HORTICULTURE
WRITTEN EXAMINATION

2:00pm Thursday 7th July 2011

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.

ANSWER ALL QUESTIONS

MARKS

Q1 Name the **FOUR** base pairs of DNA showing how they are most commonly paired. **2**

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Q2 State **TWO** techniques that plant breeders can use to ensure hybridisation in the production of F_1 hybrids. **2**

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Q3 Describe the role of ethylene in the production of a **NAMED** fruit crop. **2**

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Please see over/…..

ANSWER ALL QUESTIONS

MARKS

Q4 State **TWO** advantages of the use of seed banks in the preservation of germplasm. **2**

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Q5 Define the term ‘night break lighting’ in relation to the production of a **NAMED** plant/crop. **2**

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Q6 Define the term ‘genetic code’. **2**

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Q7 State the significance of minimum leaf number in crop production. **2**

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ANSWER ALL QUESTIONS

MARKS

Q8 Describe what is meant by multiple dormancy in seeds. **2**

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Q9 Describe **TWO** methods of breaking bud dormancy in **NAMED** plant crops. **2**

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Q10 Define the term ‘net assimilation rate’. **2**

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**The Royal Horticultural Society, Wisley, Woking, Surrey, GU23 6QB.
RHS Registered Charity No: 222879/SC038262**

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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 Evaluate the role of **EACH** of the following in preservation of genetic material:

i) preservation of natural environments; **5**
ii) botanic gardens; **5**
iii) seed banks; **5**
iv) herbaria. **5**

Q12 a) Describe the role of **EACH** of the following in the efficiency of cross fertilisation:

i) physical factors; **6**
ii) biological factors. **6**

b) Describe the impact of these on plant breeding. **8**

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Please see over/…..

Section C – Plant Physiology II

Answer TWO questions from this section

MARKS

Q13 a) Describe phytochrome as a pigment for light absorption. **6**

b) Describe the role of phytochrome in the flowering response of a **NAMED** plant. **6**

c) Describe how flowering is manipulated for commercial production of the plant named in b). **8**

Q14 Describe the effects of crop canopy and spatial arrangement on:

i) light availability; **5**
ii) water availability; **5**
iii) nutrient availability; **5**
iv) yield. **5**

Q15 Describe factors that affect the post-harvest control of quality for:

i) storage of root vegetables; **5**
ii) transportation of top fruit; **5**
iii) retailing for salads; **5**
iv) transportation of cut flowers. **5**

Q16 a) Describe the effects of **EACH** of the following in plants:

i) auxins; **4**
ii) gibberellins; **4**
iii) cytokinins; **4**
iv) ethylene. **4**

b) Describe **TWO** examples of interaction between any PGRs in plants. **4**

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MODULE G

Genetics, Plant Breeding & Systematic Botany
Plant Physiology II

Candidates Registered	**29**		**Total Candidates Passed**	**23**	**92.0%**
Candidates Entered	25	86.21%	Passed with Commendation	10	40.0%
Candidates Absent	2	6.90%	Passed	13	52.0%
Candidates Deferred	2	6.90%	Failed	2	8.0%
Candidates Withdrawn	0	-			

Section A – Short Answer Questions

Q1 Name the **FOUR** base pairs of DNA showing how they are most commonly paired.

A good knowledge of the four base pairs of DNA: cytosine, guanine, adenine and thymine were shown. There was some minor confusion in the common pairing of the four bases.

Q2 State **TWO** techniques that plant breeders can use to ensure hybridisation in the production of F_1 hybrids.

A very good knowledge of plant breeding was shown, which provided accurate and informative information on plant hybridization.

Q3 Describe the role of ethylene in the production of a **NAMED** fruit crop.

The majority of candidates mis-read the question and provided information on the function of ethylene. The question requested information relating to the use of ethylene in the production of a named fruit crop. Many candidates omitted the fruit crop example.

Q4 State **TWO** advantages of the use of seed banks in the preservation of germplasm.

Excellent examples were provided by candidates in respect to the advantages and use of seed banks in the preservation of germplasm. The majority of candidates were awarded full marks for this question.

Q5 Define the term ‘night break lighting’ in relation to the production of a **NAMED** plant/crop.

Many candidates were confused over night-break lighting and blackouts. The plant crop in many cases was incorrect, as candidates related their answers to the use of blackouts rather than night-break lighting.

Q6 Define the term ‘genetic code’.

A very poorly answered question. A common answer was a gene contains all the inherited characteristics. Whilst this statement is generally true, the question required further in-depth information based at level 3 Diploma level.

Q7 State the significance of minimum leaf number in crop production.

An incomplete answer was provided by the majority of candidates. Many candidates failed to record the age of the plant and secondary vegetative growth which is influenced by the minimum leaf number of the plant.

Q8 Describe what is meant by multiple dormancy in seeds.

Multiple dormancy was explained very well by the majority of candidates. Good plant examples were provided in candidate answers.

Q9 Describe **TWO** methods of breaking bud dormancy in **NAMED** plant crops.

Many candidates mis-read the question and provided information (mainly accurate) for this question on breaking seed dormancy, which was not required for this question. The answer should have included: high temperatures, ethylene smokes and high and low temperatures with bulb forcing.

Q10 Define the term ‘net assimilation rate’.

A technical question which was efficiently answered by the majority of candidates. Some confusion with the calculation of net assimilation rate was observed, however the concept was clearly understood by the majority of candidates.

Sections B & C – Structured Questions

Section B - Genetics, Plant Breeding & Systematic Botany

Q11 Evaluate the role of **EACH** of the following in preservation of genetic material:

i) preservation of natural environments;
ii) botanic gardens;
iii) seed banks;
iv) herbaria.

The aim of this question was to allow candidates to discuss the benefits and disadvantages of each of the stated facilities in the preservation of genetic material. Most candidates could identify the benefits of each but few discussed the disadvantages in terms of preservation of genetic material.

i) Preservation of natural environments
Most candidates stated that this was the best way of preserving genetic material not only for plants but also supported biodiversity in the wider ecosystem. Some candidates put forward their views on global destruction of rainforests; others discussed more local specific environments in relation to preservation of plant communities and specific genera.
Candidates who discussed 'in situ' conservation and the benefits or disadvantages of continuing evolution and natural selection, maintenance of land races and the potential source of wild type breeding material gained more marks.

ii) Botanic Gardens
The role of Botanic Gardens in the preservation of genetic material as 'in situ' and 'ex situ' plant collections used for plant identification, research, education and as a source of valuable plant material for propagation and dissemination was well known. Most candidates were familiar with at least one Botanic Garden and its roles.

iii) Seed Banks
Most candidates were aware of the Millennium Seed Bank at Wakehurst Place, the rationale behind its operation, the technical aspects of preservation of seeds at low temperatures and low humidity and the ability to preserve a very wide range of genetic material in the form of seeds. The benefits included the storage and preservation of a large range of plant species from a wide range of countries and habitats, the potential for reintroduction of plant species if habitat and species loss occurred and the storage of genetic material for future breeding programmes. Some disadvantages mentioned were maintaining the storage technology, seed viability monitoring, and selection pressure on retaining viability in storage.

iv) Herbaria
Most candidates identified Herbaria as catalogued collections of non living, dried or preserved plant material containing historical specimens, which included type specimens for comparison and correct identification of plants. Few candidates named a specific herbarium. Although the genetic material is preserved and can be used as a source of DNA for research into biochemical and molecular genetics it cannot be used to regenerate living plant specimens with present technology.

Q12 a) Describe the role of **EACH** of the following in the efficiency of cross fertilisation:

i) physical factors;
ii) biological factors.

b) Describe the impact of these on plant breeding.

The aim of this question was for candidates to describe some appropriate physical and biological factors that affected the efficiency of cross fertilisation following cross pollination, and then to describe the implications of these on plant breeding techniques and outcomes.
Very few candidates attempted this question. Answers to part a) should have included factors that affected the ratio of cross pollination versus self pollination, the effectiveness of cross pollination and the biological factors such as incompatibility systems that prevented cross fertilisation after successful cross pollination.
Physical factors that affect the efficiency of cross pollination would include wind speed, temperature, relative humidity, rainfall, physical barriers, distance between pollen source and recipient plant.
Biological factors are those that promote the incidence of cross pollination such as protandry, protogyny, dimorphism, monoecism and dioecism. A description of these with appropriate plant examples gained marks. Description of incompatibility systems that prevented cross fertilisation also gained marks.
In part b) the application of this knowledge to successful plant breeding systems such as production of F_1 hybrids by ensuring cross pollination and cross fertilisation by various techniques should be described. Marks were given for the impact of each appropriate factor of the success of cross fertilisation and the breeding technique employed.

Section C – Plant Physiology II

Q13 a) Describe phytochrome as a pigment for light absorption.

b) Describe the role of phytochrome in the flowering response of a **NAMED** plant.

c) Describe how flowering is manipulated for commercial production of the plant named in b).

Phytochrome as a pigment for light absorption was explained efficiently by the majority of candidates. It was disappointing however to observe very poor quality diagrams which many candidates used to support their answers. If diagrams are to be included in candidates answers (in this case it was not requested), it is essential that the diagram is clearly labelled and is sufficiently large enough to read the annotation.
The role of phytochrome was correctly explained by the majority of candidates. Plant examples were generally poor and candidates failed to record if the plant was a short day plant or a long day plant.
The manipulation of flowering for commercial production was very general. Many candidates failed to record: photoperiodic lighting, cyclic lighting and blackouts. It is important to record the timing of additional lighting or blackouts, which in most cases relates to the market date for the crop; this was omitted by the majority of candidates.

Q14 Describe the effects of crop canopy and spatial arrangement on:

i) light availability;
ii) water availability;
iii) nutrient availability;
iv) yield.

Not a popular question. Light availability was answered efficiently. Some candidates did not record the reflection of red light with older plants; this is the reason why older leaves are removed on some crops.
Answers relating to water availability were very good and showed the majority of candidates had a clear understanding of this topic area.
Nutrient availability was poorly answered by the majority of candidates. Many candidates did not mention foliar feeding. In addition the leaf area index must be considered when timing fertiliser applications. Also the source/sink concept should have been referenced in candidates answers, this was not, however the case.
Yield was satisfactorily answered by the majority of candidates. Two areas however, were not commonly recorded in candidate answers. Crops with 100% leaf cover which relates to harvesting all at the same time was not explained. In addition the modern method of growing baby vegetables with high fertiliser applications in short periods of time was not explained in candidate answers.

Q15 Describe factors that affect the post-harvest control of quality for:

i) storage of root vegetables;
ii) transportation of top fruit;
iii) retailing for salads;
iv) transportation of cut flowers.

The storage of root vegetables was well explained by the majority of candidates. One area which was not commonly recorded was the reduction of relative humidity down to approximately 30%. It is important however, to relate relative humidity to temperature, which in this case should have been 5°C. Rapid cooling of root vegetables is an important element to consider.
Transportation of top fruit was generally well answered. The majority of candidates failed to mention spraying the fruit with edible wax and grading the fruit before transporting the crop. It is also important to remember that moving air (which is cooled) is important in order to prevent fungal problems. This is particularly important for long distance transport.
Retailing for salads was well answered by the majority of candidates. Many candidates however, failed to mention vacuum cooling which is a fast and efficient method in the storage of leafy salad crops. In addition little mention was made about the crop before it is harvested. It is essential that the crop is not suffering water stress before harvesting.
Transportation of cut flowers was very generally answered. Many answers stated that the crop is plunged in water; this clearly is incorrect and certainly would cause major quality problems. It is important to remember that if temperature is reduced down to approximately 7°C, the relative humidity is reduced down to at least 40%. Low air temperatures can increase relative humidity which at high levels will quickly deteriorate developing flowers.

Q16 a) Describe the effects of **EACH** of the following in plants:

i) auxins;
ii) gibberellins;
iii) cytokinins;
iv) ethylene.

b) Describe **TWO** examples of interaction between any PGRs in plants.

A botanical question, which required precise answers. Many candidates however provided very general answers which were almost identical for each plant hormone. It is fully appreciated that plant hormones have multi-functions. It was expected that candidates would identify the main function of each listed plant hormone.
A major confusion exists with the role of auxin in many candidate answers. Incorrect answers included ripening fruit and the senescence of leaves. Many candidates also failed to mention cell differentiation with cytokinins. Cytokinins and auxins used together in tissue culture in order to stimulate cell differentiation. In many candidate answers the two plant growth regulators were used to slow down plant growth which is not correct.

The plant growth regulator containing gibberellins is used to overcome vegetative and/or sexual bud dormancy which naturally occurs within the plant - influenced by the plant producing abscisic acid. This was rarely recorded by candidates.
In addition plant growth regulators containing antagonistic plant hormones which result in short internodes and therefore dwarf plants were not discussed in candidate answers.