RHS LEVEL 3 DIPLOMA IN HORTICULTURE
WRITTEN EXAMINATION

2:00pm Thursday 11th February 2010

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 **ONE** benefit of a **NAMED** spatial arrangement on plant yield. **2**

……

……

……

……

……

Q2 State with **TWO** horticultural examples, how genetic modification has been used in practice. **2**

……

……

……

……

……

Q3 List **FOUR** safety procedures that should be followed when applying pesticides to a flower crop. **2**

……

……

……

……

……

Q4 List **FOUR** potential benefits for plant quality when growing crops under protection compared with outdoor production. **2**

……

……

……

……

……

Please see over/…..

ANSWER ALL QUESTIONS

MARKS

Q5 State **TWO** methods of controlling environmental factors for the storage of horticultural crops. **2**

……

……

……

……

……

Q6 State the specific function in plant propagation of:

i) auxins;
ii) cytokinins. **2**

……

……

……

……

……

Q7 State how meiosis differs from mitosis. **2**

……

……

……

……

……

Please turn over/…..

ANSWER ALL QUESTIONS

MARKS

Q8 State **FOUR** benefits of cross pollination. **2**

……

……

……

……

……

Q9 Distinguish between Pr and Pfr in the phytochrome reaction. **2**

……

……

……

……

……

Q10 Distinguish between the terms ‘seed stratification’ and ‘seed scarification’, using **NAMED** examples. **2**

……

……

……

……

……

****

RHS LEVEL 3 DIPLOMA IN HORTICULTURE
WRITTEN EXAMINATION

2:00pm Thursday 11th February 2010

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) Describe **TWO** methods of selecting parents with desired features for the development of a new F_1 hybrid. **4**

b) Describe **FOUR** methods of preventing 'selfing' in the seed parent during the production of an F_1 hybrid. **8**

c) State the genotype and phenotype of F_1 generation, if a pure line parent with dominant alleles for red flowers are recessive alleles for smooth stems; was crossed with a pure line parent with recessive alleles for white flowers and dominant alleles for hairy stems. **2**

d) Using a Punnett square, determine the expected genotypes and phenotypes of the F_2 generation produced by 'selfing' the resulting F_1 plants. **6**

Q12 a) Describe the plant characteristics used in a floral key. **4**

b) Outline the external characteristics of a **NAMED** plant family for **EACH** of the following:

i) the floral formula;
ii) the floral diagram. **10**

c) List **SIX** horticultural merits of the selected plant family named in b). **6**

****

Please see over/…..

Section C – Plant Physiology II

Answer TWO questions from this section

MARKS

Q13 a) Describe how aerobic and anaerobic respiration affects **EACH** of the following:

i) plant growth; **4**
ii) post harvest storage; **5**
iii) shelf life of crops. **5**

b) Describe how the control of cellular respiration can extend the shelf life of a **NAMED** crop. **6**

Q14 a) Define the term seed dormancy. **2**

b) Describe how **EACH** of the following affects seed dormancy:

i) a physical factor; **2**
ii) a chemical within the plant; **3**
iii) photoperiodic response of dormancy; **3**
iv) temperature. **2**

c) Identify **ONE** method of overcoming **EACH** type of dormancy specified in b), using a **NAMED** example. **8**

Q15 a) Describe how **EACH** of the following affects the initiation of flowering:

i) photoperiodic response; **4**
ii) temperature. **2**

b) Explain the classification of plants according to photoperiodic response. **4**

c) Describe **EACH** of the following in relation to the production of flowering plants:

i) interrelationship of temperature and photoperiod; **4**
ii) the management of a flowering crop. **6**

Please turn over/…..

Section C – Plant Physiology II

Answer TWO questions from this section

			MARKS
Q16	a)	Differentiate between plant growth and development.	**4**
	b)	Explain the term physiological age (juvenility), in plants.	**4**
	c)	Explain the interrelationship of physiological age (juvenility), minimum leaf number, and phytochrome on the development of plants.	**10**
	d)	State **TWO** benefits of maintaining juvenile plant growth in horticultural practice.	**2**

****

RHS LEVEL 3 DIPLOMA IN HORTICULTURE
WRITTEN EXAMINATION

2:00pm Thursday 11th February 2010

MODULE G

Genetics, Plant Breeding & Systematic Botany
Plant Physiology II

Candidates Registered	**48**		**Total Candidates Passed**	30	73.17%
Candidates Entered	41	85.42%	Passed with Commendation	7	17.07%
Candidates Absent	4	8.33%	Passed	23	56.10%
Candidates Deferred	3	6.25%	Failed	11	26.83%
Candidates Withdrawn	0	-			

Section A – Short Answer Questions

Q1 State **ONE** benefit of a **NAMED** spatial arrangement on plant yield.

The aim of the question is to ascertain if the candidates can identify a spatial arrangement and state the benefit it confers to crop yield. High marks were awarded for naming e.g. double rows, bed systems, square plantings with clear statements of the benefits e.g. evenly developed, uniform crop ready for once over harvest.

Q2 State with **TWO** horticultural examples, how genetic modification has been used in practice.

The aim of the question is to ascertain if the candidates can identify TWO horticultural examples of genetic modification as used in practice. High marks were awarded for citing the blue carnation 'Moonshadow' that was developed by the Australian company Florigene Ltd. There is no gene for blue colouration in carnations, so this was incorporated from a pansy using genetic modification. High marks were also awarded for other examples e.g. maize that has been inserted with an insecticide derived from the bacterium *Bacillus thuringiensis* to reduce insect damage.

However, the question stated 'used in practice'. A large number of candidates quoted examples of GM still under going tests for release, or indeed experimentation, marks were awarded for these as well.

Q3 List **FOUR** safety procedures that should be followed when applying pesticides to a flower crop.

The aim of the question is to ascertain if the candidates can cite **FOUR** safety procedures that should be followed when applying pesticides to a flower crop. High marks were awarded for listing any of the following: PPE, use of the correct dose, spray in appropriate environmental conditions, use the appropriate sprayer / equipment for the task.

Q4 List **FOUR** potential benefits for plant quality when growing crops under protection compared with outdoor production.

The aim of the question is to ascertain if the candidates can list **FOUR** potential benefits for plant quality when growing crops under protection when compared with outdoor production.

High marks were awarded for listing comparative benefits between growing outdoors and under protection. E.g. Lactuca sativa 'Little Gem' grown under protection would not display soil from rain splash, unlike lettuce grown outdoors, which would; thus reducing quality and end price.

Q5 State **TWO** methods of controlling environmental factors for the storage of horticultural crops.

The aim of the question is to ascertain if the candidates can state **TWO** methods of controlling environmental factors for the storage of horticultural crops.

High marks were awarded for statements which included information about reducing the temperature of crop at harvest by removal of field heat and then using a low temp storage regime or statements about CA stores with details of gaseous mixtures.

Q6 State the specific function in plant propagation of:

i) auxins;
ii) cytokinins.

The aim of the question is to ascertain if the candidates can state the relationship between auxins and cytokinins in the context of plant propagation.

High marks were awarded for statements which included information about the use of these PGRs in tissue culture i.e. that IAA is a naturally occurring auxin which encourages root initiation and cytokinins are involved in shoot initiation. In tissue culture the proportions of these are varied to effect either root or shoot formation.

Q7 State how meiosis differs from mitosis.

The aim of the question is to ascertain if the candidates can distinguish between meiosis and mitosis. High marks were awarded for statements which cited that meiosis occurs in sexual organs and produces genetically distinct cells, whilst mitosis produces identical daughter cells. Mitosis occurs in all dividing cells, meiosis produces 4 new haploid cells, whilst mitosis produces 2 diploid cells.

Q8 State **FOUR** benefits of cross pollination.

High marks were awarded for answers that included the following:

Reduces the incidence of inbreeding depression;
Different array of genes enhances the likelihood of combating unknown pests and diseases;
Increases gene pool, therefore it is unlikely that a species will be come extinct;
New and interesting characteristics develop in the progeny.

Q9 Distinguish between Pr and Pfr in the phytochrome reaction.

The aim of the question is to ascertain if the candidates can distinguish between Pr and Pfr in the phytochrome reaction.

High marks were awarded for answers that mentioned that phytochrome is a light sensitive pigment which occurs in two forms: Pr and Pfr. Sunlight contains red and far-red wavelengths in approximately equal amounts. Red light produces the biologically active form Pfr of the pigment, while far-red light converts Pfr back to the biologically inactive form, Pr.

Q10 Distinguish between the terms ‘seed stratification’ and ‘seed scarification’, using **NAMED** examples.

The aim of the question is to ascertain if the candidates can distinguish between 2 commonly used seed dormancy breaking practices.

High marks were awarded for answers that clearly distinguished between these seed dormancy breaking techniques i.e. that stratification is the layering seeds in moist soil, compost, or sand and maintaining them at low temperatures in order to break dormancy e.g. *Quercus robur, Fagus sylvatica, Primula veris*. Whereas scarification is the process of abrading the seed coat, testa, to allow the imbibition of water through an otherwise impermeable seed coat e.g. *Lathyrus odoratus*.

Sections B & C – Structured Questions

Section B - Genetics, Plant Breeding & Systematic Botany

Q11 a) Describe **TWO** methods of selecting parents with desired features for the development of a new F_1 hybrid.

b) Describe **FOUR** methods of preventing 'selfing' in the seed parent during the production of an F_1 hybrid.

c) State the genotype and phenotype of F_1 generation, if a pure line parent with dominant alleles for red flowers are recessive alleles for smooth stems; was crossed with a pure line parent with recessive alleles for white flowers and dominant alleles for hairy stems.

d) Using a Punnett square, determine the expected genotypes and phenotypes of the F_2 generation produced by 'selfing' the resulting F_1 plants.

The aim of the question was to allow candidates to demonstrate their knowledge of practical and theoretical aspects of plant breeding related to the production of F_1 hybrids and also to determine the genotype and phenotype of F_1 and F_2 results from dihybrid crosses without gene linkage.

In answer to part a), candidates who described methods of selection of potential parents for an F_1 hybrid and identified possible characteristics for selection were rewarded. Most candidates were able to state that parents of F_1 hybrids should be pure lines, i.e. homozygous at all gene loci. Methods of obtaining homozygous plants other than by selfing for 5-6 generations, such as by anther culture, were also suggested. Other relevant points such as the parents should be compatible and flower at the same time were occasionally mentioned.

b) Methods of preventing selfing in the seed parent were better presented although not always described in any detail. Candidates who were able to describe methods of prevention of self pollination in the seed parent with suitable named examples of genera gained maximum marks. These included emasculation, physical removal of anthers containing pollen, removal of male flowers from monoecious plants, self- incompatibility of pollen, and protandry or protogyny-using the natural mechanism of the plant species to limit self pollination.

c) Most candidates identified the phenotype of the F_1 generation as being red flowers with hairy stems, as the two dominant alleles. The genotype would be written as RrHh. The convention of using **R** as depicting the Dominant allele – red flowers and **r** as depicting recessive allele for white flowers was not always followed. This led to difficulty for some candidates in answering part d). If candidates had obtained the correct genotype for the F_1 generation they were able to construct the Punnett square using correct gamete genotypes to obtain the F_2 ratios.

Gametes	RH	Rh	rH	rh
RH	RRHH	RRHh	RrHH	RrHh
Rh	RRHh	RRhh	RrHh	Rrhh
rH	RrHH	RrHh	rrHH	rrHh
rh	RrHh	Rrhh	rrHh	rrhh

There were some very clear answers to this and some candidates used colour coding to help identify the phenotypes in the F_2. The final ratios were 9 red flowers with hairy stems: 3 red flowers with smooth stems: 3 white flowers with hairy stems: 1 white flower with smooth stem.

Q12 a) Describe the plant characteristics used in a floral key.

b) Outline the external characteristics of a **NAMED** plant family for **EACH** of the following:

i) the floral formula;
ii) the floral diagram.

c) List **SIX** horticultural merits of the selected plant family named in b).

The aims of the question were to describe how knowledge of the morphology of plants assists in their identification and to describe the botanical and horticultural characteristics of a named plant family using floral formula and floral diagram.

a) The plant characteristics used in keying out and identifying a plant to family, genus and possibly species include vegetative morphological characteristics such as growth habit, leaf arrangement, stem and possibly root characteristics, as well as inflorescence structure, flower and fruit morphology. Some candidates included a detailed description of how a dichotomous key operates, which could not be rewarded while others confused floral key with floral formula.

b) The most commonly selected family was Rosaceae with a range of other families, not all from the syllabus, represented in candidates' answers.
The floral formulae stated were mostly accurate indicating whether flower was actinomorphic or zygomorphic, indicating the correct classification and number of floral parts, whether these were free or fused, any attachment of one part to another, i.e. epipetalous stamens, and whether the gynaecium was superior or inferior.
Good examples of floral diagrams were large, clear and indicated the number arrangement of floral parts, sepals, petals or perianth segments, stamens and the structure of the ovary and placentation of ovules within it.

c) There were many good answers listing the horticultural merits of the selected plant family with named genera allocated to the specific merit showing extensive plant knowledge. However agricultural, medicinal and other industrial merits listed could not be credited with marks.

Candidates are advised to take time in order to read and interpret the question and allocate their time according to the mark distribution.

Section C – Plant Physiology II

Q13 a) Describe how aerobic and anaerobic respiration affects **EACH** of the following:

i) plant growth;
ii) post harvest storage;
iii) shelf life of crops.

b) Describe how the control of cellular respiration can extend the shelf life of a **NAMED** crop.

The aim of the question is to assess if candidates understand the effect of respiration rate on post-harvest physiology.

a) i) High marks were awarded for accurate and pertinent descriptions of the effect of respiration rate on post-harvest physiology. e.g. A full description of the effects aerobic and anaerobic have on plant growth, highlighting the fact that aerobic respiration produces 36 ATP molecules and anaerobic respiration only 2 ATP molecules, was awarded high marks.

ii) High marks were awarded for accurate and pertinent descriptions of the relationship between respiration and post harvest storage which included information on the effect of temperature on respiration; breakdown products, effect of fungi on respiration rates, and a description of post harvest storage environments e.g. ambient storage, CA stores.

iii) High marks were awarded for accurate and pertinent descriptions of the relationship between respiration and the shelf life of crops which included information on e.g. the fact that low temperature will reduce respiration and increase shelf life, a description of how respiration rate can be modified to increase shelf life and also a description of the effect of aerobic and anaerobic respiration on the shelf life of crops.

b) High marks were awarded for an introduction which described cellular respiration and then a description of how it can extend the shelf life of a **NAMED** crop. High marks were awarded for information on the cool chain and associated technology e.g. MAP.

Q14 a) Define the term seed dormancy.

b) Describe how **EACH** of the following affects seed dormancy:

i) a physical factor;
ii) a chemical within the plant;
iii) photoperiodic response of dormancy;
iv) temperature.

c) Identify **ONE** method of overcoming **EACH** type of dormancy specified in b), using a **NAMED** example.

The aim of the question is to assess knowledge of a key term used in plant physiology i.e. 'Seed dormancy' and to determine if candidates can describe the physical causes of seed dormancy and also describe methods of dormancy breaking in seeds, with named examples.

a) High marks were awarded for an accurate and precise definition e.g. 'seeds that fail to grow when the environmental conditions are favourable for growth' Science and the Garden second edition 2008.

b) High marks were awarded for accurate and pertinent descriptions of each of the causes of seed dormancy. e.g. In iv) high marks were awarded for a full description of thermodormancy in 'Lactuca sativa ' named cultivar' and the conditions which precipitate this mode of dormancy. Other examples of the effect of temperature on dormancy e.g. low temperature effects, double dormancy, were also awarded high marks.

c) High marks were awarded for accurate and pertinent dormancy breaking methods relevant to an appropriately named example in each case. e.g. b) i), in hardseedness in peas, *Pisum sativum*, scarifying the seeds (by various means) in order to abrade the seed coat to allow the imbibition of water, but all the time ensuring that the embryo is not damaged in any way.

Q15 a) Describe how **EACH** of the following affects the initiation of flowering:

i) photoperiodic response;
ii) temperature.

b) Explain the classification of plants according to photoperiodic response.

c) Describe **EACH** of the following in relation to the production of flowering plants:

i) interrelationship of temperature and photoperiod;
ii) the management of a flowering crop.

The aim of the question is to assess candidates' knowledge of the effect of temperature and photoperiod on flower bud initiation and development.

a) High marks were awarded for accurate and pertinent descriptions of i) photoperiod as the critical day length (indeed length of the night), which triggers flowering in certain plants. Flowering is triggered when a critical photoperiod is reached (details included). ii) High marks were awarded for accurate and pertinent descriptions of how flower initiation is promoted by a previous exposure to low temperature.

b) High marks were awarded for accurate explanations of the difference between SDP, LDP and DN and Intermediate plants with emphasis on the critical photoperiod and length of night.

c) i) High marks were awarded for accurate and pertinent descriptions of the interrelationship of temperature and photoperiod which described factors such as the association of low temperature (vernalisation) and photoperiod allowing plants to respond more precisely to seasonal changes followed by discussion that the majority of plants requiring vernalisation also require subsequent exposure to long days in order to induce flowering. This ensures seed production under optimal conditions.

c) ii) Higher marks were awarded to candidates who could relate the practical methods used by the horticulturist to facilitate the development of a flowering crop. Marks were awarded to candidates who demonstrated a clear understanding of blackouts, photoperiodic lighting and irrigation systems used in the production of a flowering crop.

Q16 a) Differentiate between plant growth and development.

b) Explain the term physiological age (juvenility), in plants.

c) Explain the interrelationship of physiological age (juvenility), minimum leaf number, and phytochrome on the development of plants.

d) State **TWO** benefits of maintaining juvenile plant growth in horticultural practice.

The aim of the question is to assess candidates' knowledge of the physiology of plant growth and development.

a) High marks were awarded for answers which clearly differentiated that *Growth* arises from the creation of new cells and the increase in their size whilst *Development* is the result of cells differentiating into a diversity of tissues that make up organs such as roots, shoots, leaves, and flowers.

b) High marks were awarded for answers that explained that juvenility is the term given to the early phase of growth (often lasting many years in trees) during which flowering cannot be induced by any treatment. The plant remains vegetative and does not change to its reproductive stage.

c) High marks were awarded for answers that explained that the minimum leaf number is the minimum number of leaves that a plant requires before it will switch from vegetative to reproductive stage. The change from juvenile to adult takes place at the shoot apex after the plant reaches a certain size. High marks were awarded for answers that explained that the transition from juvenile to reproductive is mediated by phytochrome in many plants.

d) High marks were awarded for answers that stated the benefits of juvenile plant material to plant propagation and amenity horticulture.