Candidate Number:……

Candidate Name:……

Centre Number/Name:……

RHS LEVEL 3 DIPLOMA IN HORTICULTURE
WRITTEN EXAMINATION

2:00pm Thursday 5th July 2007

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.

MODULE G

Genetics, Plant Breeding & Systematic Botany
Physiology of Flowering, Reproduction & Development

Section A – Short Answer Questions

Please turn over/…..

ANSWER ALL QUESTIONS

MARKS

Q1 Distinguish between the terms genotype and phenotype. **2**

……

……

……

……

……

Q2 Define **EACH** of the following terms used in plant breeding:

i) haploid;
ii) tetraploid. **2**

……

……

……

……

……

Q3 Name **TWO** components of the nucleus and define the function of **EACH**. **2**

……

……

……

……

……

Please see over/…..

ANSWER ALL QUESTIONS

MARKS

Q4 Distinguish between a chimera and a mutation. **2**

……

……

……

……

……

Q5 Define **EACH** of the following terms:

i) net assimilation rate;
ii) crop growth rate. **2**

……

……

……

……

……

Q6 Define the term ‘vernalisation’. **2**

……

……

……

……

……

Q7 State **TWO** functions of abscisic acid. **2**

……

……

……

……

……

ANSWER ALL QUESTIONS

MARKS

Q8 Distinguish between actinomorphic and zygomorphic flowers, giving a **NAMED** example of **EACH**. **2**

.....

.....

.....

.....

.....

Q9 Define the term phyllotaxy, providing **TWO** distinct plant examples. **2**

.....

.....

.....

.....

.....

Q10 Define the term ‘accumulated cold units’ in crop production. **2**

.....

.....

.....

.....

.....

****

RHS LEVEL 3 DIPLOMA IN HORTICULTURE
WRITTEN EXAMINATION

2:00pm Thursday 5th July 2007

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.

MODULE G

Genetics, Plant Breeding & Systematic Botany
Physiology of Flowering, Reproduction & Development

Sections B & C

Structured Questions

Please turn over/…..

Section B - Genetics, Plant Breeding & Systematic Botany

Answer ONE question only from this section

MARKS

Q1 a) Describe the botanical characteristics of **EITHER** *Rosaceae* **OR** *Liliaceae* with the aid of a floral formulae and floral diagrams. **10**

b) Construct a floral key using botanical characteristics to identify **FIVE NAMED** genera from **ONE** of these families. **10**

Q2 a) List the advantages and disadvantages of cross pollination to the plant. **4**

b) Describe, using **NAMED** examples, the variety of mechanisms that are used by plants to:

i) limit self pollination;
ii) ensure cross pollination. **8**

c) Describe the techniques that a plant breeder could use to produce F_1 hybrid seed from a naturally inbreeding plant such as *Pisum sativum*. **4**

d) An F_1 hybrid pea was produced by crossing two pure line parents, one tall and round seeded, the other, dwarf with wrinkled seed. The dominant genes were **TALL** and **WRINKLED**. The F_1 hybrid peas were allowed to self-pollinate and the seed collected, then sown. Use a Punnet square to demonstrate the ratio of phenotypes that would be found in the F_2 generation. **4**

****

Please see over/…..

Section C – Physiology of Flowering, Reproduction & Development

Answer TWO questions from this section

MARKS

Q3 a) Discuss how environmental factors influence the shelf life of fresh fruit and vegetables. **8**

b) Describe how these factors may be controlled to maximise the shelf life for **NAMED** examples of fresh fruit and vegetables. **12**

Q4 a) Outline the structure and function of phytochrome. **4**

b) Describe its role in:

i) germination; **4**
ii) stem elongation; **4**
iii) day length response of a **NAMED** glasshouse crop. **8**

Q5 a) Distinguish between the following forms of seed dormancy:

i) innate;
ii) induced;
iii) enforced. **6**

b) Discuss, using **NAMED** plant examples, the effect that the following have on breaking seed dormancy:

i) chemicals;
ii) temperature;
iii) light and darkness. **14**

Q6 a) Define physiological age. **4**

b) Describe how it may influence flowering. **4**

c) Describe **THREE** methods used to overcome the effects of juvenility in commercial production of **THREE NAMED** plants. **12**

****

RHS LEVEL 3 DIPLOMA IN HORTICULTURE
WRITTEN EXAMINATION

Thursday 5th July 2007

MODULE G

Genetics, Plant Breeding & Systematic Botany
Physiology of Flowering, Reproduction & Development

Examiners Report

Candidates Registered	37				
			Total Candidates Passed		
Candidates Entered	30	81.08%	Passed with Commendation	7	23.33%
Candidates Absent	5	13.51%	Passed	13	43.33%
Candidates Deferred	1	2.70%	Failed	10	33.33%
Candidates Withdrawn	1	2.70%			

Section A – Short Answer Questions

Q1 Distinguish between the terms genotype and phenotype.
This question was adequately answered. However many candidates did not distinguish between genotype and phenotype but rather defined each term and left it to the examiner to surmise a distinction. Marks were gained where candidates gave examples of the genotype using for example, allele combinations and then describing how these manifest in the phenotype.

Q2 Define **EACH** of the following terms used in plant breeding:

iii) haploid;
iv) tetraploid.
v)

This question was well answered. High marks were awarded for answers that stated that haploid contained 1 set of chromosomes (n) and the tetraploid 4 sets (4n)

Q3 Name **TWO** components of the nucleus and define the function of **EACH**.

This question was adequately answered. A common mistake was to confuse nucleus with nucleolus. High marks were awarded for components including: chromatin, nucleolus, and nuclear membrane. Definitions which stated the following were awarded high marks:
Chromatin: the complex of proteins, DNA and small amounts of RNA of which chromosomes are composed.
Nucleolus: a structure within the nucleus which stains densely with basic dyes and consists of proteins associated with RNA.
Nuclear membrane: a membrane surrounding the nucleus. The outer membrane is studded with ribosomes on the cytoplasm side whilst the surface of the inner membrane next to the nucleus is smooth.
Another error was to define the nucleus and describe it's function. As this error was so often repeated, the examiner decided to allow it if defined as: Nucleus: the part of a eukaryotic cell that contains the genetic material. It is enclosed in a nuclear membrane.

Q4 Distinguish between a chimera and a mutation.
This question was adequately answered. However candidates described graft hybrids in a few cases instead of chimeras. High marks were awarded for distinguishing chimeras as a plant or plant part that consists of two or more genetically different types of cells, with a description of sectorial chimeras. Contrasting this with mutations which are inherited changes in the genes cased by a number of factors eg. Radiation, mutagens, aging and which may even be spontaneously induced.

Q5 Define **EACH** of the following terms:

iii) net assimilation rate;
iv) crop growth rate.

This question was well answered. High marks were awarded for answers that stated that NAR is a measure of the effectiveness of photosynthesis and CGR is the rate of increase in weight per unit of ground ie C = LxE

Q6 Define the term 'vernalisation'.
This question was well answered. High marks were awarded for answers that defined it as a term used to describe the increase in flowering that occurs in response to cold treatment given to seeds or young plants, but it is not a method of breaking seed dormancy.

Q7 State **TWO** functions of abscisic acid.
This question was well answered. High marks were awarded for answers that stated any of the following;
Promotes leaf and fruit abscission,
Promotes senescence
Controls dormancy
Prevents cell elongation and shoot growth
Inhibits seed germination and some tropic responses
Regulates stomatal closure and thus reduces water loss by transpiration in times of drought.

Q8 Distinguish between actinomorphic and zygomorphic flowers, giving a **NAMED** example of **EACH**.
This question was well answered. High marks were awarded for answers that distinguished actinomorphy as radial symmetry and zygomorphic flowered as having only one plane of symmetry with appropriate examples in each case.

Q9 Define the term phyllotaxy, providing **TWO** distinct plant examples.
This question was well answered. High marks were awarded for answers that defined phyllotaxy as the arrangement of leaves on the stem with basic patterns as whorled, spiral, alternate or opposite, with appropriate examples.

Q10 Define the term 'accumulated cold units' in crop production.
This question was only just adequately answered. Candidates were not able to give details in many instances. High marks were awarded for answers that defined ACU thus, the amount of cold required before forcing or dormancy breaking can be started is referred to as cold units. Cold units are the accumulated number of degrees below 9.45C/49F (and above -2.2C/28F) as recorded at mid-morning.

Section B - Genetics, Plant Breeding & Systematic Botany

Q1 a) Describe the botanical characteristics of **EITHER** *Rosaceae* **OR** *Liliaceae* with the aid of a floral formulae and floral diagrams.

b) Construct a floral key using botanical characteristics to identify **FIVE NAMED** genera from **ONE** of these families.
This was not a popular question in that only one candidate attempted it. The question was well written to allow candidates to demonstrate their knowledge of a plant family and some of its constituent genera.

In part a) the botanical characteristics of the chosen plant family were to be described supported by a floral formula and a floral diagram to show the number and arrangement of the different floral parts.
In part b) candidates could demonstrate their knowledge of the characteristics of 5 correctly named genera within the selected family, by contracting a key using flower structure, or perhaps fruit type, to key out the genera ie. For the family Rosaceae, the genera Prunus, Rosa, Fragaria, Rubus and Malus.

Q2 a) List the advantages and disadvantages of cross pollination to the plant.
Candidates were expected to identify the advantages and disadvantages of cross-pollination to the plant (not the plant breeder). Advantages would include variation in the gene pool, hybrid vigour and ability to adapt and evolve in changing environment. The disadvantages could include a less stable genotype, more variation in the offspring, less adapted to a stable environment and higher energy demands on the plant in terms of producing nectar, scent or production of large volumes of pollen.

b) Describe, using **NAMED** examples, the variety of mechanisms that are used by plants to:
   iii) limit self pollination;
   iv) ensure cross pollination.

Mechanisms used by plants to limit self-pollination ie, to make self pollination less likely include dichogamy, either protandry or protogyny, monoecism – separate male and female flowers on the same plant, and rhe dimorphism or heterostyly in Primula spp.
Mechanisms to ensure cross-pollination and remove all chances of self-pollination include dioecious plants, where male and female flowers are on separate plants, and sporophytic and gametophytic incompatibility of pollen with the parent plant. All examples of relevant mechanisms were to be linked to appropriately named plants.

c) Describe the techniques that a plant breeder could use to produce F_1 hybrid seed from a naturally inbreeding plant such as *Pisum sativum*.
In a naturally inbreeding plant, the normal method of pollination is self-pollination, therefore a plant breeder must use techniques to prevent self-pollination in the two pure line parents of F_1 hybrids.
Techniques that are employed by plant breeders are removal of anthers/stamens – emasculation of female seed parent, using male sterile plants as seed parent, hand pollination to transfer selected pollen from the anthers of the male pollen parent to the female seed parent, exclusion of any other pollen from the pollinated flowers by covering with bags r insect proof netting. Credit was also given for any other valid plant breeding techniques used to produce F_1 hybrids from inbreeding parents.

d) An F_1 hybrid pea was produced by crossing two pure line parents, one tall and round seeded, the other, dwarf with wrinkled seed. The dominant genes were **TALL** and **WRINKLED**. The F_1 hybrid peas were allowed to self-pollinate and the seed collected, then sown. Use a Punnet square to demonstrate the ratio of phenotypes that would be found in the F_2 generation.

This was a question on dihybrid inheritance with non-linked genes. Using a Punnet square to display the genotypes of potential gamete recombinations in the F_2 generation, the resulting phenotypes could be identified as 9 Tall and Wrinkled, 3 Tall and Round, 3 Dwarf and Wrinkled and 1 Dwarf and Round following the instructions re dominance given in the question. Where candidates had assumed that Round was dominant to Wrinkled the following predicted ratio was allowed: 9 Tall and Round, 3 Tall and Wrinkled, 3 Dwarf and Round, 1 Dwarf and Wrinkled.

Candidates found it difficult to correctly define monoecious and dioecious and to distinguish between mechanisms limited self-pollination and ensuring cross-pollination. There was some confusion between F_1 and F_2 generations and the genotype of gametes in dihybrid inheritance, also in the construction of a Punnet square, but most candidates were aware of the correct expected 9:3:3:1 ratio of offspring in the F_2 generation.
The question required careful reading by candidates to ensure that their answers included the required information, were blanced according to the marks required for each section and included the NAMED plant examples asked for in part b).

Section C – Physiology of Flowering, Reproduction & Development

Q3 a) Discuss how environmental factors influence the shelf life of fresh fruit and vegetables.
Answers were required to include, heat, cold, humidity and atmospheric gas, technical detail on how these factors influence the shelf life of fresh fruit and vegetables was required. Many answers did not include all of factors which resulted in lower marks.

b) Describe how these factors may be controlled to maximise the shelf life for **NAMED** examples of fresh fruit and vegetables.
Some very general answers which in many cases did not specifically relate to fresh fruit and vegetables. Answers should have included, rapid cooling, controlled atmospheric gas storage, refrigerated storage and vacuum storage.

Q4 a) Outline the structure and function of phytochrome.

Answers were limited on the structure of phytochrome. The function of phytochrome was more fully explained but often just related to photosynthesis.

b) Describe its role in:
iv) germination;
v) stem elongation;
vi) day length response of a **NAMED** glasshouse crop.
i) Some good answers from candidates who explained how the pr/pfr relationship affects the hormonal balance in seeds and can affect germination process.

ii) The affect of red light received by the terminal buds which relates to gibberelin production was essential for this answer. Very general answers recorded which did not explain the pr/pfr influence in stem elongation.

iii) Some good answers however many candidates did not relate:
a) size of plant before long or short days (short nights/long nights)
b) the length of period which light control is required, this relates to the specific crop. Most candidates used spray chrysanthemums. It is important to note that temperature is also important in this area of plant response.

Q5 a) Distinguish between the following forms of seed dormancy:
iv) innate;
v) induced;
vi) enforced.

i) The dormancy is within the seed and is transferred (genetically) from the mother plant. A ripening period is required before the seed can germinate.
ii) The dormancy is forced onto the seed by changing the required germination requirements ie. Light/dark, temperature and O_2 levels.
iii) Dormancy still exists after conditions for innate and induced dormancy have been successfully achieved for the seed. It is called secondary dormancy, stimulation of the seed will be required ie light / dark temperature and high O_2 levels.

b) Discuss, using **NAMED** plant examples, the effect that the following have on breaking seed dormancy:

iv) chemicals;
v) temperature;
vi) light and darkness.

i) The range of chemicals used to break seed dormancy was required. Answers should include the use of acids (named) and plant growth regulators (named) ie gibberelins and ethylene.
ii) The use of cold storage for seeds in respect to actual temperature and length of time with cold temperatures was required. The concept of vernalisation would assist the answer.
High temperatures to break dormancy on temperate / tropical named plant examples were also required.
iii) The effect of red light on dormancy was required. In addition the duration of red light affecting seeds was essential for the answer. The chemical changes in the seed affected by Red light (Pr/Pfr) was discussed by some candidates who were awarded higher marks.

Q6 a) Define physiological age.
Answers should have included:
- The stage of the plant development not the chronological age of the plant
- The reaction of specific plant hormones to influence plant growth and development was required
-

b) Describe how it may influence flowering.
Answers should relate to the stage of plant development which is affected by external factors ie light and temperature. The relationship of the release of plant hormones (named) and the external conditions was essential for this answer. The concept of mature and juvenile growth was required in the answer

c) Describe **THREE** methods used to overcome the effects of juvenility in commercial production of **THREE NAMED** plants.

A range of methods are available which include:
- The use of rootstocks ie. Apples
- Budding and grafting ie ornamental trees
- Treatment to the stock plant ie avoiding hard pruning ie ornamental shrubs
- Zonal selection of cutting material from the stock plant ie conifers
- Photoperiodic control of plant growth ie cut flowers

Answers were very general and in many cases did not relate to named plant examples.