Candidate Number: ……

Candidate Name: ……

Centre Number/Name: ……..

RHS LEVEL 3 DIPLOMA IN HORTICULTURE
WRITTEN EXAMINATION

Thursday 6th July 2006

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 and Systematic Botany
Physiology of Flowering, Reproduction and Development

Section A - Short Answer Questions

Please turn over/……

ANSWER ALL QUESTIONS

Marks

Q1 Define the term 'backcross'. **2**

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Q2 Distinguish between:

a) interspecific hybridization;
b) mutation breeding. **2**

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Q3 Distinguish between senescence and dormancy in plants and **NAME ONE** growth regulator, which is present in **EACH** case. **2**

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Q4 Define the term 'epinasty'. **2**

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Please see over/……

ANSWER ALL QUESTIONS

Marks

Q5 State the use of a floral key in the identification of plants. **2**

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Q6 State the relevance of 'limiting factor' to the process of photosynthesis. **2**

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Q7 Describe **TWO** functions of growth hormones in autumn leaf fall. **2**

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ANSWER ALL QUESTIONS

Marks

Q8 Describe the relevance of herbaria to systematic botany. **2**

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Q9 State Mendel's First Law of Inheritance. **2**

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Q10 Distinguish between the following genetic terms:

a) heterozygous;
b) homozygous. **2**

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RHS LEVEL 3 DIPLOMA IN HORTICULTURE
WRITTEN EXAMINATION

Thursday 6th July 2006

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 and Systematic Botany
Physiology of Flowering, Reproduction and Development

Sections B & C

Structured Questions

Please turn over/……

Section B – Genetics, Plant Breeding and Systematic Botany

Answer ONE question only from this section

Marks

Q1 a) List the advantages of F_1 hybrids over open pollinated crops. **4**

b) Describe in detail the process of producing F_1 hybrid seed of a natural outbreeder, including methods of producing and maintaining pure lines as parent lines. **10**

c) If the F_1 crop was allowed to set seed and this seed sown, state the expected ratios of the original two parental phenotypes in the F_2 generation for:

i) one characteristic;
ii) di-hybrid crosses without gene linkage. **2**

d) Total number of seeds harvested from the F_2 was 240. The original parental phenotypes were yellow, round seed (both characteristics dominant) and green, wrinkled seed (both characteristics recessive).

Calculate the predicted numbers of yellow round seed, yellow wrinkled seed, green round seed and green, wrinkled seed. **4**

Q2 a) List the characteristics, which the breeder may wish to incorporate into a new variety of **NAMED** crop or plant. **6**

b) Explain the breeding techniques required to incorporate the following sources of variation which the plant breeder could use to produce new varieties:

i) plant selection from an outbreeding population;
ii) wild species. **6**

c) Outline the potential effects of the following sources of variation:

i) polyploidy;
ii) male sterility;
iii) mutagenic agents. **8**

Please see over/……

Section C – Physiology of Flowering, Reproduction & Development

Answer TWO questions from this section

			Marks
Q3	a)	Explain why monoculture and the exclusion of weeds is normally adopted in horticultural crop production.	**8**
	b)	Review how an appreciation of weed biology can be used in order to maximize yield and quality.	**12**
Q4	a)	Define the term 'critical day length'.	**2**
	b)	Review, using **NAMED** examples, the techniques that growers use to manipulate flowering in plants.	**12**
	c)	Explain the importance of photoinductive cycles.	**6**
Q5	a)	**NAME FOUR** distinct synthetic growth regulators available to the horticulturist and state the function of **EACH**.	**8**
	b)	Describe, using **NAMED** examples, how synthetic growth regulators are used in **EACH** of the following situations:	
		i) fruit production;	**6**
		ii) flower production.	**6**
Q6	a)	Compare the processes of aerobic and anaerobic respiration in plants.	**6**
	b)	Outline how **EACH** of the processes in a) affect the storage life of horticultural products.	**6**
	c)	Describe the optimum pre- and post-harvest conditions required to maximise the shelf-life of **ONE NAMED** fruit crop and **ONE NAMED** vegetable crop.	**8**

RHS (LEVEL 3) DIPLOMA IN HORTICULTURE
WRITTEN EXAMINATION

Thursday 6th July 2006

Module G

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

Examiners Comments

Candidates Registered	67		Total Candidates Passed		
Candidates Entered	59	88.06%	Passed with Commendation	3	5.09%
Candidates Absent	3	4.48%	Passed	23	38.98%
Candidates Deferred	4	5.97%	Failed	33	55.93%
Candidates Withdrawn	1	1.49%			

Section A - Short Answer Questions

Q1 *Define the term 'backcross'.*

This question was poorly answered. Candidates described rather than DEFINED the term. High marks were given for definitions which included the technique of repeated crossing to one parent and where the repeated parent was named the recurrent and the other the non-recurrent. Marks were also awarded if the term defined 'test cross', where a cross was made between an individual of uncertain genetic constitution and a parent that is homozygous recessive to ascertain identity.

Q2 *Distinguish between:*

a) interspecific hybridization;
a) mutation breeding.

This question was well answered. High marks were given when a clear distinction was made between interspecfic hybridization being a breeding technique which enables for crossing of different cultivars, races or species and mutation breeding being a technique which relies on the production of mutations either spontaneous or induced using irradiation, chemicals etc.

Q3 *Distinguish between senescence and dormancy in plants and **NAME ONE** growth regulator, which is present in **EACH** case.*

This question was well answered. High marks were given for the contrast between senescence as the beginning of plant death and decay and dormancy being an imposed state of rest. High marks were awarded for the appropriate citing of hormones e.g. Ethylene and ABA.

Q4 *Define the term 'epinasty'.*

This question was poorly answered. High marks would have been awarded for the following definition. A nastic (plant responses caused by external stimuli) movement in which the resultant bending of the plant part is downwards, due to increased growth on the upper side of an organ.

Q5 *State the use of a floral key in the identification of plants.*

This question was poorly answered. In more than 50% of answers candidates described a floral diagram and not a floral key. High marks were awarded where the use of a dichotomous key and its correct application was described.

Q6 *State the relevance of 'limiting factor' to the process of photosynthesis.*

This question was well answered. High marks were awarded where answers stated the **relevance** of the 'Limiting Factor' to the process of photosynthesis.

Q7 *Describe **TWO** functions of growth hormones in autumn leaf fall.*

This question was only adequately answered. A common mistake was to misinterpret the role of abscisic acid. Though abscisic acid was originally thought to regulate both abscission and bud dormancy ABA now appears to have little to do with either of these phenomena. High marks were awarded where answers stated that it was the reduction in auxin levels which started the process of abscission.

Q8 *Describe the relevance of herbaria to systematic botany.*

This question was well answered. High marks were given for a detailed description of the relevance of herbaria to systematic botany. This included a description of type specimens and their use in plant identification and nomenclature: keeping records of the discovery of new species migration and extinction and knowing which species are becoming rare or endangered due to human activity.

Q9 *State Mendel's First Law of Inheritance.*

This question was poorly answered. In more that 50% of answers candidates were unable to state the law. High marks were awarded when THE LAW OF SEGREGATION was cited and the following statement made: that while an organism may contain a pair of contrasting alleles these will separate at the formation of gametes so that only one will be present in a single gamete.

Q10 *Distinguish between the following genetic terms:*

a) heterozygous;
b) homozygous.

This question was well answered. High marks were given for the accurate distinction between an individual that has formed from gametes possessing contrasting alleles of a single gene and an individual that has formed from gametes possessing identical alleles of a given gene.

Section B - Genetics, Plant Breeding and Systematic Botany

Q1 *a) List the advantages of F_1 hybrids over open pollinated crops.*

b) Describe in detail the process of producing F_1 hybrid seed of a natural outbreeder, including methods of producing and maintaining pure lines as parent lines.

c) If the F_1 crop was allowed to set seed and this seed sown, state the expected ratios of the original two parental phenotypes in the F_2 generation for:

i) one characteristic;
ii) di-hybrid crosses without gene linkage.
iii)

d) Total number of seeds harvested from the F_2 was 240. The original parental phenotypes were yellow, round seed (both characteristics dominant) and green, wrinkled seed (both characteristics recessive).

Calculate the predicted numbers of yellow round seed, yellow wrinkled seed, green round seed and green, wrinkled seed.

a) This as well covered by most candidates except for the point that not all F_1 hybrids necessarily possess pest and disease resistance.

b) Candidates were asked to describe in detail the process of producing F_1 hybrid seed using pure lines as parent lines. This was **to include** methods of producing and maintaining the pure lines. Many candidates described methods of producing the homozygous parent lines by repeated selfing or anther culture followed by colchicine treatment of the monoploid seedlings, at the expense of describing how the breeder would then produce the F_1 seeds. Better candidates included growing the parental lines in close proximity. emasculation or using a male sterile seed parent to prevent selfing, excluding other sources of pollen and pollinators, transferring pollen by hand from the made pollen parent, or by insects such as flies or bees in enclosed green houses.

c) Most candidates knew the expected ratios for the F_2 generation for monohybrid (3.1) and dihybrid inheritance (9.3.3.1). However many candidates did not fully read the question for part c) and did not give the ratios for the two original **parental phenotypes** and thus lost marks.

d) Using the expected 9.3.3.1 ration many candidates completed this section correctly. The predicted numbers of seed were

Yellow round	$\frac{9}{16} \times 240 = 135$
Yellow wrinkled	$\frac{3}{16} \times 240 = 45$
Green round	$\frac{3}{16} \times 240 = 45$
Green wrinkled	$\frac{1}{16} \times 240 = 15$

Some candidates lost marks due to arithmetic errors

Q2 *a) List the characteristics, which the breeder may wish to incorporate into a new variety of **NAMED** crop or plant.*

b) Explain the breeding techniques required to incorporate the following sources of variation which the plant breeder could use to produce new varieties:

i) plant selection from an outbreeding population;
ii) wild species.

c) Outline the potential effects of the following sources of variation:

i) polyploidy;
ii) male sterility;
iii) mutagenic agents.

a) Most candidates were able to give an interesting list of appropriate characteristics relevant to the one NAMED selected amenity plant or crop showing good plant knowledge.

b) A variety of answers were written in response to this part of the question.

i. Candidates were awarded marks for indicating that the outbreeding population was heterozygous, selection occurred at population level for the desired characteristics and that repeated selection was practiced to obtain the new selected lines.

ii. Candidates showing knowledge of the technique of backcrossing selected offspring from a cross between a related wild species possessing a desirable characteristic and a commercial variety gained most marks.

Wild species are often used as a source of disease resistance, which can be incorporated into a commercially successful variety with no resistance.

The technique used is cross-pollination, selfing and selection followed by repeated backcrossing of the resistant offspring to the commercial plant until disease resistance is incorporated into the commercial variety.

c) Most candidates had an understanding of the effects that polyploidy, male sterility and mutagenic agents had on variability. Better candidates were able to define polyploidy and the effects on named polyploidy plants including possible sterility. Additionally to describe male sterility and its practical effects in a breeding programme for producing F1 hybrids avoiding the need for emasculation, and to name mutagenic agents and their effects on chromosomes, DNA and the resulting beneficial or deleterious mutations.

Section C - Physiology of Flowering, Reproduction & Development

Q3 *a) Explain why monoculture and the exclusion of weeds is normally adopted in horticultural crop production.*

b) Review how an appreciation of weed biology can be used in order to maximize yield and quality.

The highest marks in part (a) were given when answers were divided into two sections and included explanations as to why monoculture and weed exclusion is normally adopted. Answers which included mention of: reduction in competition, less risk of pest and disease spread, reduction in crop contamination by weed seeds and debris, easier scheduling of operations (irrigation, spraying, harvesting) and ease of mechanisation for just one crop type were all rewarded.

In section (b) many candidates failed to identify and appreciate the importance of weed biology when trying to maximise yield and quality. Highest marks were awarded when factors including the different control strategies for annual and perennial weeds and their differing reproductive mechanisms were highlighted. The circumstances in which to use contact, systemic and residual herbicides and operations to minimise weed seed germination and establishment were often ignored.

Q4 *a) Define the term 'critical day length'.*

*b) Review, using **NAMED** examples, the techniques that growers use to manipulate flowering in plants.*

c) Explain the importance of photoinductive cycles.

Critical day length is the daily duration of light above which short-day plants do not flower (or are delayed), or below which long-day plants do not flower (or are delayed). It is <u>not</u> a set number of hours which plants need in order to flower.

Example techniques used by growers to manipulate flowering were correctly identified as for example, daylength manipulation (night breaks, blackouts and supplementary lighting), vernalisation, application of synthetic growth regulators, use of temperature (refrigeration) to hold back plants and disbudding.

The importance of photoinductive cycles was poorly explained. Better answers included a description of the role of phytochrome to illicit a biological response and how that affected plant survival processes such as dormancy-breaking, flowering and germination in some species.

Q5 *a)* ***NAME FOUR*** *distinct synthetic growth regulators available to the horticulturist and state the function of* ***EACH****.*

b) *Describe, using* ***NAMED*** *examples, how synthetic growth regulators are used in* ***EACH*** *of the following situations:*

i) *fruit production;*
ii) *flower production.*

A suitable range of synthetic growth regulators were named along with their appropriate functions. Examples included Pachlobutrazol, an anti-gibberellin to shorten stem length and 2,4-D, a synthetic auxin to promote cell division. Ethylene did not receive any mark as it is not a synthetic growth regulator. Ethrel C is an acceptable alternative.

A wide range of examples were described to illustrate how synthetic growth regulators are used within flower and fruit production. Suitable examples included Chlormequat to control stem length in bedding plants, and NAA to encourage fruit set in pears.

Q6 *a)* *Compare the processes of aerobic and anaerobic respiration in plants*
.

b) *Outline how* ***EACH*** *of the processes in a) affect the storage life of horticultural products.*

c) *Describe the optimum pre- and post-harvest conditions required to maximise the shelf-life of* ***ONE NAMED*** *fruit crop and* ***ONE NAMED*** *vegetable crop.*

Candidates could correctly compare the two processes and outline the effects of each upon storage life. However, most marks were lost regarding optimum pre and post-harvest conditions for named crops. Factors such as ensuring the crop was at the correct stage for harvest, appropriate weather conditions for harvesting, removal of field heat by vacuum cooling or forced air cooling and entering the cool chain system could all have been included appropriate to the named crop. No marks were awarded when inappropriate crops were cited.

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