Candidate Number: ……..

Candidate Name: ……..

Centre Number/Name: ……

RHS (LEVEL 3) DIPLOMA IN HORTICULTURE
WRITTEN EXAMINATION

Thursday 8th February 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 and Systematic Botany, Physiology of Flowering, Reproduction and Development.

Section A – Short Answer Questions

Please turn over/…..

ANSWER ALL QUESTIONS

MARKS

Q1 Describe the process of transcription that occurs in protein synthesis. **2**

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Q2 State, with reference to **NAMED** plant examples, **TWO** distinct uses of the Solanaceae family. **2**

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Q3 Define the following plant terms:

i) growth;
ii) development. **2**

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Q4 State **TWO** ways a grower could ensure the production of a **NAMED** vegetable to meet the requirements of the canning industry. **2**

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Please see over/…..

ANSWER ALL QUESTIONS

MARKS

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

i) crop growth rate;
ii) crop leaf area. **2**

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Q6 Distinguish between endogenous and synthetic growth regulators. **2**

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Q7 State **TWO** advantages and **TWO** disadvantages of self pollination. **2**

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Q8 State **TWO** main differences between **TWO** plant breeding techniques. **2**

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ANSWER ALL QUESTIONS

MARKS

Q9 For a **NAMED** plant family, state **TWO** features of the floral structure. **2**

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Q10 Explain what is meant by allele. **2**

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RHS (LEVEL 3) DIPLOMA IN HORTICULTURE
WRITTEN EXAMINATION

Thursday 8th February 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 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)	**i**	Define and compare the processes of mitosis and meiosis in plants.	**8**
	ii	Explain the significance of **EACH** process.	**2**
	b)	Explain how, using clearly labelled diagrams, the four daughter cells by meiosis are unlikely to be identical to each other or to the original gametes that fuse together.	**10**
Q2 a)		Describe the process of pollination in a **NAMED** plant, indicating how the floral structure is adapted for pollination.	**8**
	b)	Describe in detail the process of fertilization in plants.	**6**
	c)	Explain how pollination can be controlled by the plant breeder.	**6**

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Please see over/…..

Section C - Physiology of Flowering, Reproduction and Development

Answer TWO questions only from this section

MARKS

Q3 a) Define the terms in the equation:

i) C = L x E;
ii) Explain the equation with reference to crop yield. **8**

b) Explain how crop canopy and spatial arrangement can affect crop yield. **8**

c) State the advantages and limitations of monoculture in crop production. **4**

Q4 Explain how **NAMED** plant growth regulators are involved in **EACH** of the following:

i) fruit set and parthenocarpy; **5**
ii) fruit storage and ripening; **5**
iii) tissue culture; **5**
iv) production of pot chrysanthemums. **5**

Q5 a) Explain how photoperiodic responses affect the seasonal flowering of plants/crops. **10**

b) Review the use of artificial manipulation of the photoperiod to control flowering in a **NAMED** plant/crop. **10**

Q6 a) Explain the photoperiodic induction of dormancy in deciduous woody plants with the aid of **NAMED** examples. **8**

b) Describe the possible effects of temperature and abscisic acid on the induction of dormancy. **6**

c) Describe **TWO** methods of dormancy breaking in woody plants. **6**

RHS (LEVEL 3) DIPLOMA IN HORTICULTURE
WRITTEN EXAMINATION

Thursday 8th February 2007

Module G

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

Examiners Report

Candidates Registered	79		Total Candidates Passed		
Candidates Entered	67	84.81%	Passed with Commendation	17	25.37%
Candidates Absent	3	3.80%	Passed	33	49.25%
Candidates Deferred	7	8.86%	Failed	17	25.37%
Candidates Withdrawn	2	2.53%			

Section A – Short Answer Questions

Q1 Describe the process of transcription that occurs in protein synthesis.

Candidates confused transcription and translation. High marks were awarded for an accurate description of transcription as the part of protein synthesis that involves the formation of a complementary copy of the genetic code by messenger RNA synthesis.

Q2 State, with reference to **NAMED** plant examples, **TWO** distinct uses of the Solanaceae family.

This question was well answered. High marks were obtained for answers that followed the Rubric.

Q3 Define the following plant terms:

iii) growth;
iv) development.

Candidates described rather than defined the plant terms. High marks were obtained for answers that quoted the following definitions:

a) increase in size, weight and mass of plant parts
b) Physiological changes from juvenility, adulthood, senescence and death.

Q4 State **TWO** ways a grower could ensure the production of a **NAMED** vegetable to meet the requirements of the canning industry.

This question was poorly answered. High marks were obtained for answers that named ONE vegetable not TWO and which focused the answer to the requirements of the caning industry and not conventional production for other markets.

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

i) crop growth rate
ii) crop leaf area

This question was well answered, in the main. High marks were awarded for an accurate definition NOT a description of crop growth rate and crop leaf area i.e.

a) increase in weight per unit area of ground area (C=LxE)
b) area of leaf per unit area of ground cover.

Q6 Distinguish between endogenous and synthetic growth regulators.

This question was poorly answered. Candidates did not distinguish between endogenous and synthetic growth regulators. High marks were awarded for an accurate distinction between the two, using named examples for an endogenous growth regulator and its synthetic counterpart e.g. in auxins IAA / IBA, NAA etc.

Q7 State **TWO** advantages and **TWO** disadvantages of self pollination.

This question was well answered in the main. High marks were awarded for answers that stated the following e.g. but not exclusively:
Do not require a different source of pollen
Better colonisation of new habitats
Problems associated with inbreeding depression
Reduction in gene pool

Q8 State **TWO** main differences between **TWO** plant breeding techniques.

This question was very poorly answered. Candidates did not state TWO plant breeding techniques nor were TWO main differences given. Also, candidates mistakenly quoted tissue culture as a plant breeding technique when it is a method of propagation, instead of referring to genetic modification or protoplast fusion in this context.

Q9 For a **NAMED** plant family, state **TWO** features of the floral structure.

This question was well answered in the main, High marks were awarded for accurate features of the Named plant family's floral structure.

Q10 Explain what is meant by allele.

This question was poorly answered. High marks were awarded for an explanation of an allele NOT alleles, as usually two, sometimes more, forms of a gene occurring at the same relative position (locus)on each of a pair of homologous chromosomes.

Structured Questions
Section B – Genetics, Plant Breeding and Systematic Botany

Q1 **a)** i Define and compare the processes of mitosis and meiosis in plants.

More candidates selected this question to answer but varied in their knowledge of the mechanics and significance of mitosis and meiosis.
Definitions of mitosis and meiosis were sometimes missing from the answers; comparisons should bring out mainly differences, such as maintaining number of chromosomes (mitosis), reduction in number of chromosomes e.g. from diploid to haploid (meiosis), production of 2 identical cells (mitosis) production of 4 non identical cells (meiosis), mitosis occurs in meristematic cells, meiosis only occurs in cells producing gametes in anthers and ovules, but also similarities such as the stages of prophase, metaphase, anaphase and telophase. Diagrams of the process of mitosis were not specifically asked for and may have taken time which candidates should have used on the second half of the question.

ii Explain the significance of **EACH** process.

Most candidates were able to explain the significance of mitosis; some were not able to explore fully the significance of meiosis in producing haploid gametes with increased genetic variation and allowing combination of genes from two parents at fertilization which allows evolution and adaption of plants to specific environments to occur.

b) Explain how, using clearly labelled diagrams, the four daughter cells by meiosis are unlikely to be identical to each other or to the original gametes that fuse together.

This section of the question required candidates to draw clearly labelled diagrams of specific stages in the process of meiosis. Explanation was required of the pairing of homologous chromosomes, the bivalents, at synapsis in Prohase 1, crossing over and exchange of DNA between chromatids and random assortment of maternal and paternal chromosomes from homologous pairs at Metaphase 1 and Anaphase 1, with the resulting distribution of non-identical chromatids during Anaphase of the second division of meiosis giving four non-identical haploid cells. Large diagrams using colour to show the results of crossing over helped to distinguish between individual chromatids and show variation in the final four gametes.
Very few candidates were able to do this convincingly but there were some excellent answers showing full understanding of the mechanics and implications of meiosis.

Q2 a) Describe the process of pollination in a **NAMED** plant, indicating how the floral structure is adapted for pollination.

Fewer candidates chose this question to answer.
Good candidates were able to exhibit knowledge of the flower structure of a **named plant** and were able to identify specific colour markings, shape or scent of the flower to the method of insect or wind pollination. They were also able to discuss the relationship between the position and form or rigidity of anthers or stigmas in the transfer of pollen as well as presence or absence of petals, honey guides, nectar or scent and the type and quality of pollen produced.

b) Describe in detail the process of fertilization in plants.

Some candidates had difficulty in differentiating between pollination and fertilization. Candidates who achieved highest marks on this section described with the aid of a large, well –labelled diagram(s), germination of the pollen grain, the location of the male and female gametes, the pollen tube male nuclei and contents of the embryo sac including the egg cell, and the process of double fertilization with formation of the diploid zygote and triploid endosperm nucleus.

c) Explain how pollination can be controlled by the plant breeder.

There were some very good answers n methods of controlling pollination used by plant breeders, mainly to prevent self pollination and ensure cross pollination by the selected pollen. Most candidates were able to discuss three or more methods using specific plant examples although this was not asked for in the question. These methods included exclusion of unwanted pollen by distance, isolation or barriers, exclusion of pollinators by growing under protection, using netting or using air filters, supplying compatible pollen donors, supplying pollinators such as bees, flies or pollinating by hand. Different methods of removal of pollen from the seed parent or ensuring self pollination by emasculation, or chemical or cytoplasmic male sterility were also valid.
Descriptions of formation of fruits and seeds and methods of dispersal were not asked for and did not gain any marks. Candidates must read the question carefully.

Section C - Physiology of Flowering, Reproduction and Development

Q3 a) Define the terms in the equation:

iii) C = L x E;
iv) Explain the equation with reference to crop yield.

i) asked for a definition of the terms within the equation
C = L x E. A high percentage of candidates were able to answer very well noting that it was:

Crop Growth Rate, which equalled the leaf area index multiplied by the Net Assimilation Rate (NAR).

ii) this question asked to explain the equation with reference to crop yield.

Similarly, candidates proved very knowledgeable and many answers were received in annotated diagrams. Answers, which gained high marks, identified that leaf area index was the area of ground covered by plant leaves, but this had a dependency upon the maturity of the plant as leaves grew larger and covered a wider area.

Net Assimilation Rate (NAR) is the amount of energy assimilated by photosynthesis. The NAR is photosynthesis minus the respiration rate. The higher the NAR, the better the crop growth.

b) Explain how crop canopy and spatial arrangement can affect crop yield.

It was important to note that if the crop canopy is too dense or conversely too sparse, it can affect both the quality and quantity of the crop. There is an optimum spacing regime for each specific crop, which permits maximum potential growth. At certain densities, better husbandry, feeding (nutrients), watering and light provision (photosynthesis) are more likely to increase crop yield. Candidates showed a good understanding of this concept and as a result gained good marks. Knowledgeable candidates used key words with supporting evidence such as photosynthesis, mutual shading, optimum spacing and the use of LAI indices.

c) State the advantages and limitations of monoculture in crop production.

Several candidates adopted bullet points to express their answers, some lists whilst others used continuous dialogue. Some candidates who gained average marks tended to focus upon the advantages and neglected the limitations. Nevertheless, this section of the question proved quite favourable.

Advantages
Tasks could be undertaken for the entire crop ie, sowing, weeding spraying, feeding and harvesting. The field can be prepared for a single crop, allowing for easy mechanisation and ease of operation and produces a uniform crop.

Disadvantages
Should the crop fall foul of pest or disease attack, the entire crop could be lost. Similarly should the crop experience poor weather/climatic conditions such as drought or prolonged rainfall, the crops could also be lost. There is a likelihood of poor biodiversity; soil becomes exhaustive of nutrients or collapse in the market prices leading to negative equity.

Candidates did not always appear to recognise the distribution of marks and gave adequate length responses appropriately to what was required to gain good marks.

Q4 Explain how **NAMED** plant growth regulators are involved in **EACH** of the following:

v) fruit set and parthenocarpy;
vi) fruit storage and ripening;
vii) tissue culture;
viii) production of pot chrysanthemums.

For the majority of candidates, this proved to be a demanding question and marks awarded were generally poor to moderate. Yet noticeably, one or two centres clearly covered this area well, and associated candidates scored high marks without exception.

The question asked for an explanation on named growth regulators for four specific areas.

i) Fruit set and parthenocarpy. Answers would include both auxins and gibberellins as part of the growth regulation in fruit set, with parthenocarpy and is the establishment of the fruit without complete fertilization taking place. The spraying of auxin during the flowering period increased the fruit set and assists in the promotion of a uniform harvest.

Many candidates identified specific anti-gibberellins such as chlormequat chloride (cycocel), Daminocide (B nine), Noragib or Pachlobutrazol. The mention of growth regulators to specific fruits was occasionally used with related doses and at what weather conditions application was best done, with what type of application was preferred.

ii) Fruit storage and ripening. The majority of candidates understood the concept but few were able to gain maximum marks. Examiners were looking for an understanding of growth regulators and that first storage suffers from the potentially damaging effects of ethylene ($C_2 H_4$). It requires an understanding of the gas and how it diffuses through the tissues to enable the fruit to ripen (Cavendish bananas) and *Lycopersicon esculentum* (tomato).

It is important to indicate that the knowledge by fruit producers of ethylene enables the ability to control the ripeness of the fruit to the consumer. The use of synthetic growth regulators (Ethrel C) mimics the ripening of fruit once it has been harvested where fruit has climacteric properties which permit ripening post harvest before the fruits optimum ripeness is obtained. An example commonly given, was bananas as they tend to be harvested green and Ethrel C or similar is used to bring them to market standard. It was also important to note that ethylene causes senescence and excessive ripening means that every effort has been made to ensure over ripening of the fruit which is near decay, is away from other produce. Other answers included controlled atmosphere stores for *Malus domestica* (apples) which often incorporate ethylene scrubbers. Modified atmostphere packaging for Rubus ideaus (raspberrys) can include a small package of Equisols – an ethylene scrubber.

iii) The majority of candidates appeared to appreciate the concept of growth regulators related to tissue culture, and gave good accounts. Marks tended to range between moderate to good with few scoring poorly.

Examiners were looking for Cytokinin being used to increase the production of adventitious shoots (plant cell division) in the pre-transplant or initial stage of micropropagation.

iv) The forth element to the question relates to growth regulators involved in the production of pot chrysanthemums. Candidates again understood the concept but tended to give poor to moderate responses. Examiners were looking for the concept of anti gibberellins within the production of chrysanthemums being used to encourage stem extension growth reduction. The growth regulator acts as a chemical retardant in the production of tall stems. The dwarfing effect ensures compact growth, but plants will return to normal size if anti-gibberelin is not maintained.

Many growth regulators are available such as 'Cycocel', which inhibits internode elongation. Gibberellin (GA_3) can increase flowering enabling stem growth to quicken, whilst synthetic auxins offer a number of uses such as rooting powder or rooting dip.

Q5 a) Explain how photoperiodic responses affect the seasonal flowering of plants/crops.

proved to be a popular question, with many of those who attempted it giving a precise and good understanding of what the question was asking. High marks were given by interpreting the question by offering an explanation of how photoperiodic responses in relation to flowering of plants and crops and not a description or statement or bullet points. Examiners were looking for an explanation that plants responded to daylight or photoperiod and that varying plants reacted differently. It was important to identify that three types of photoperiod responses that existed in which plants reacted to, short-day, long-day or day-neutral. Definition of each response with examples gained high marks such as:

Short-day; plants that require short days and long nights before flowering is initiated; examples being Poinsettia (Euphorbia pukherima) which requires a 12 hour period of darkness for 3 months.

Long-day; plant which are required to receive long days and short nights before flowering would be initiated with Fuchia/Petunia as examples.

Day-neutral describes plants, which offer alternative ways of initiating flowering. Good candidates were able to explain that plants absorb red light during the day (Pr) where by the photochrome converts the red light into far red within the photoinductive cycle, or Pfr during the night, which in turn, triggers or initiates the effects of the phytochrome which includes managing the circadian rhythms of the plant. Circadian rhythms include leaf movement and keep the plant to a 24 hour period. Both Pr and Pfr light occurs very rapidly. During the night, Pfr light is slowly converted back to Pr light, reversing the process of the day. It is during these critical periods of Pr and Pfr that plants need to initiate flowering.

All plants require a critical period of phytochrome or Pr light and its day length above the critical period that enables plants to flower.

b) Review the use of artificial manipulation of the photoperiod to control flowering in a **NAMED** plant/crop.

Candidates were asked to review the use of artificial manipulation of the photoperiod to control flowering in a named crop. The majority of candidates understood the concept and generally marks awarded ranged between moderate to high. Most candidates were able to give an account of what artificial manipulation was and supported this with figurative facts. Most reviews were written in a logical manner with good examples.

Examiners gave credit when candidates acknowledged that artificial manipulation of the day length is used when producing plants all year round (AYR) with an example such as AYR Chrysanthemums. A time period for this process ranged between 9 – 14 weeks from initiation of flowering. The control of light time enabled maximum bud break (max commercial value). It is important for candidates to indicate that the day length must be maintained at more than the critical day length during vegetative growth, until the plant is sufficiently mature in growth and post juvenile stage.

The initiation of flowering after this may be delayed during the winter period when days are short by introducing night breaks. This method is used to reduce the Pfr and not initiating flowering by not extending the day length with continuous lighting. Intermittent lighting throughout the night enables the plant to not receive continuous darkness.

Conversely during long summer days, the blackening of the greenhouse will artificially decrease the day length below the critical value (13 - 14½) hours. This permits the grower to produce flowering plants all year round or periods of peak demand opposed to the plants natural flowering period (autumn).

It is important for the candidate to appreciate that artificial manipulation of the photoperiod is to enable plant to flower at the ideal time for the commercial market. In delaying the flowering offers greater flexibility to the grower for selling of the product. Many candidates showed their knowledge by stating the type of bulb used for artificial manipulation, the height above the plants and the time periods throughout the year.

Q6 a) Explain the photoperiodic induction of dormancy in deciduous woody plants with the aid of **NAMED** examples.

This was not to a very popular question, with few candidates attempting it. Of those who did, the marks awarded generally were between poor to moderate.

Many candidates chose Acer palmatum, Betual pendula as examples, as they conform to the deciduous requirement of the question and have woody stems. Candidates who explained the principle of photoperiodic induction of dormancy gained higher marks. There was evidence of poor understanding of the concept of dormancy and the factors affecting dormancy in woody deciduous plants.

b) Describe the possible effects of temperature and abscisic acid on the induction of dormancy.

The majority of candidates provide very general answers to this part of the question. A lack of understanding of how temperature relates to the induction of dormancy was observed by the majority of candidates. The majority of candidates did not identify clearly the site of absicisic acid production in plants and the factors affecting production of abscisic acid.

c) Describe **TWO** methods of dormancy breaking in woody plants.

The candidate's answers to this question provided limited detailed information and in most cases were very general. Most candidates did not explain how temperature, light levels and light duration can be modified in order to break dormancy in plants.