RHS LEVEL 3 DIPLOMA IN HORTICULTURE
WRITTEN EXAMINATION

2.00pm Thursday 12th February 2009

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 State **TWO** horticultural uses for plants in the family Brassicaceae, providing a **NAMED** example in **EACH** case. **2**

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Q2 Explain the disadvantages of saving F_2 seed for crop production. **2**

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Q3 State **TWO** functions of abscisic acid in the plant. **2**

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Q4 Distinguish between the terms genotype and phenotype. **2**

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Please see over/…..

ANSWER ALL QUESTIONS

MARKS

Q5 Define the term 'accumulated cold units' in the context of the commercial forcing of rhubarb. **2**

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Q6 State **FOUR** morphological features that are characteristic of a **NAMED** plant family. **2**

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Q7 Describe the structure and function of **EACH** of the following:

i) mitochondria;
ii) nucleolus. **2**

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Please turn over/…..

ANSWER ALL QUESTIONS

MARKS

Q8 Describe the process of ‘vernalisation’. **2**

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Q9 Describe the phytochrome system in plants. **2**

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Q10 Compare the process of aerobic or anaerobic respiration in plants. **2**

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2.00pm Thursday 12th February 2009

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

Q1 a) Explain how Deoxyribonucleic Acid (DNA) controls protein synthesis in the plant cell. **8**

b) Describe **TWO** practical methods of inducing mutation in plants, providing a **NAMED** plant example of horticultural benefit for each. **12**

Q2 a) Compare and contrast the botanical characteristics of the families Asteraceae and Rosaceae. **10**

b) Write the floral formulae and draw the floral diagrams for **EACH** of the plant families named in a). **4**

c) Describe the relevance of herbaria to systematic botany. **6**

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Please see over/…..

Section C – Plant Physiology II

Answer TWO questions from this section

MARKS

Q3 a) Define **EACH** of the following:

i) leaf area index; **3**
ii) net assimilation rate; **3**
iii) crop growth rate; **3**
iv) marketable yield. **3**

b) Explain how spacing and plant density influence the performance of a **NAMED** crop. **8**

Q4 a) Define **EACH** of the following common types of seed dormancy:

i) innate; **2**
ii) induced; **2**
iii) enforced; **2**
iv) double/delayed. **2**

b) Describe **ONE** method of breaking dormancy for **EACH** of the types defined in a) and give a **NAMED** example in each case. **12**

Q5 a) Describe how the vegetative and reproductive stages of a **NAMED** plant are affected by the manipulation of the photoperiod. **8**

b) Explain the importance of **EACH** of the following:

i) critical day length; **4**
ii) plant response group; **4**
iii) photo-inductive cycles. **4**

Section C – Plant Physiology II

Answer TWO questions from this section

MARKS

Q6 Explain how **NAMED** plant growth regulators are used in **EACH** of the following:

i)	fruit set and parthenocarpy;	**5**
ii)	fruit storage and ripening;	**5**
iii)	propagation by tissue culture;	**5**
iv)	a pot chrysanthemum crop.	**5**

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WRITTEN EXAMINATION

Thursday 12th February 2009

MODULE G

Genetics, Plant Breeding & Systematic Botany
Plant Physiology II

Candidates Registered	**52**		**Total Candidates Passed**	**26**	**60.47%**
Candidates Entered	43	82.69%	Passed with Commendation	5	11.63%
Candidates Absent	9	17.31%	Passed	21	48.84%
Candidates Deferred	-	-	Failed	17	39.53%
Candidates Withdrawn	-	-			

Section A – Short Answer Questions

Q1 State **TWO** horticultural uses for plants in the family Brassicaceae, providing a **NAMED** example in **EACH** case.

The aim of the question is to provide **TWO** horticultural uses for plants in the family Brassicaceae, correctly named. High marks were awarded for a complete name e.g. Brassica oleracea var capitata as a vegetable example and for a bedding plant, the correct name for wallflowers i.e Erysimum chieri

Q2 Explain the disadvantages of saving F_2 seed for crop production.

The aim of the question is to demonstrate why it is not advisable to save F_2 seed for crop production. High marks were awarded for an explanation of why the seeds do not breed true to type and also a consideration of the homozygous and heterozygous nature of the progeny and the effect of this on crops.

Q3 State **TWO** functions of abscisic acid in the plant.

The aim of the question is to provide **TWO** functions of abscisic acid in the plant.

High marks were awarded for quoting for example, that ABA is particularly involved in managing water economy in plants. ABA plays a central role in stomatal closure, control of germination i.e. mobilisation of reserves. Also, seed maturation, storage proteins and ABA prevents precocious germination.

There was some confusion about the role of ABA in both bud dormancy and leaf fall. Candidates are advised that there is no clear evidence that ABA is responsible for bud dormancy and leaf fall.

Q4 Distinguish between the terms genotype and phenotype.

The aim of the question is to demonstrate an understanding of the difference between genotype and phenotype. High marks were awarded for stating that Genotype is the genetic make up of an organism whilst Phenotype are the observable properties of an organism, produced by an interaction between the organism's genetic potential (the genotype) and the environment.

Q5 Define the term 'accumulated cold units' in the context of the commercial forcing of rhubarb.

The aim of the question is to ascertain what ACU are, how ACU are measured and what physiological change they trigger. High marks were awarded for stating the exact temperature and time of recording of ACU and that they break dormancy in rhubarb. High marks were awarded for stating the time that different cultivars required.

Q6 State **FOUR** morphological features that are characteristic of a **NAMED** plant family.

The aim of the question is to cite **FOUR** definitive morphological features of a **NAMED** plant family. High marks were awarded for a correctly named family and relevant and accurate characteristics. In the main, these were floral characteristics though in the case of Fabaceae, leaf characters and root nodules containing rhizobium were also quoted.

Q7 Describe the structure and function of **EACH** of the following:

iii) mitochondria;
iv) nucleolus.

The aim of the question is to elicit an accurate description of the structure and function of these two organelles. High marks were awarded for accurate and detailed descriptions:
E.g. mitochondria: membrane-bound, subcellular organelle in which respiration occurs in living cells. The four main parts of mitochondria are the outer membrane, inter membrane space, inner membrane, and the matrix. The inner membrane folds into cristae in order to increase surface area.

and for describing the function of the organelles as well.

Q8 Describe the process of 'vernalisation'.

The aim of the question is to ascertain if candidates could accurately describe the process of 'vernalisation'. High marks were awarded for a detailed description of the process with relevant examples. eg. 'vernalisation' describes the increase in flowering that occurs in response to a cold-treatment given to seeds or young plants NOT the exposure of seeds to low temperatures to break dormancy.

Q9 Describe the phytochrome system in plants.

The aim of the question is to ascertain if candidates could accurately describe the phytochrome system in plants. High marks were awarded for a detailed description of the system i.e descriptions of Pr and Pfr and their interconvertabilty; also stating that Pfr is the active form and an explanation of the role phytochrome plays in plant processes.

Q10 Compare the process of aerobic or anaerobic respiration in plants.

The aim of the question is to ascertain the difference between aerobic **AND** anaerobic respiration in plants. High marks were awarded for an accurate comparison of the two processes citing e.g. the two equations either in notation or in text and a comparison of the end results of the two processes, e.g. the amount of ATP produced in each case and the deleterious affects of anaerobic respiration.

Sections B & C – Structured Questions

Section B - Genetics, Plant Breeding & Systematic Botany

Q1 a) Explain how Deoxyribonucleic Acid (DNA) controls protein synthesis in the plant cell.

b) Describe **TWO** practical methods of inducing mutation in plants, providing a **NAMED** plant example of horticultural benefit for each.

The aims of the question are to allow candidates to describe the process of direction and control of protein synthesis in the plant cell by DNA, messenger RNA, transfer RNA and ribosomal RNA and to describe practical applications developed by plant breeders to take advantage of inducing mutations in DNA and changing this process.

a) In answer to part a) the processes of transcription and translation should be described including the structure of DNA, sequence of bases forming triplet codons, formation of messenger RNA on template strand of DNA, movement of mRNA out of the nucleus to the ribosomes where tRNA with matching anticodons to the sequence of codons on the mRNA bring in correct sequence of amino acids which link together through peptide bonds to form polypeptides and proteins.
Large clear diagrams were very useful in describing the structure of DNA and the processes of transcription and translation.

b) This part of the question appeared to be little more difficult for candidates to answer in detail. Induced mutations are changes in DNA induced by external factors which increase the rate of mutations in the content or amount of DNA. The factors can be physical such as forms of high energy radiation, X rays, gamma rays etc. or chemicals such as maleic hydrazide, EMS, colchicines or other chemicals which are known mutagens which damage DNA or chromosomes. Few candidates were able to describe the practical methods of treating various parts of a named plant with named mutagen, with an explanation of the effect that it caused, selection of the beneficial mutations, with a description of the horticultural benefit for each method chosen.
The use of colchicine to disrupt anaphase in mitosis and create polyploid plants was well known by the candidates.
Some candidates misinterpreted the question and described specific selected gene transfer techniques which could not be awarded marks.

Q2 a) Compare and contrast the botanical characteristics of the families Asteraceae and Rosaceae.

b) Write the floral formulae and draw the floral diagrams for **EACH** of the plant families named in a).

c) Describe the relevance of herbaria to systematic botany.

The aims of the question are to allow candidates to display their knowledge of two specific plant families, the Asteraceae and Rosaceae, and their appreciation of the importance of herbaria to the study of systematic botany.

a) Candidates were asked to compare and contrast the two families in terms of their botanical characteristics; this was most effectively achieved by use of a table to describe and list similarities and differences in inflorescence type, details of flower structure, characteristics of fruits and seeds, growth habit and distribution. Better candidates gave examples of genera within the two families to illustrate points made.

b) Candidates showed better knowledge of the floral formula and floral diagram of the Rosaceae family than the Asteraceae family, and some showed confusion between the inflorescence, a collection of florets, and the individual typical Asteraceae floret structure. All diagrams should be large, clear and preferably drawn in pencil.

c) Most candidates clearly understood the relevance of herbaria to present and future studies of systematic botany. Good points made included that

- they are a repository of ‘type’ specimens,
- they contain historical records of original specimens and descriptions of plants collected by plant hunters,
- they can be used as a reference source and research data base for international studies of plant taxonomy,
- they enable newly collected specimens to be compared with previously catalogued and named plants,
- they are used to catalogue new species
- traditionally they preserve whole pressed and dried plants but also may contain specimens of dried wood, seeds, fruits from which DNA may be extracted for future studies.

Section C – Plant Physiology II

Q3 a) Define **EACH** of the following:

v) leaf area index;
vi) net assimilation rate;
vii) crop growth rate;
viii) marketable yield.

b) Explain how spacing and plant density influence the performance of a **NAMED** crop.

The aim of the question is to assess knowledge of key terms used in plant growth analysis and to determine if candidates can distinguish between plant density and spacing and the relative impacts of these on crop growth.

High marks were awarded for accurate and precise definitions e.g. leaf area index; is the area of leaf, divided by the area of ground and that marketable yield is the total yield of the crop minus that which is ungradeable (i.e. discards, diseased, damaged crop etc).

b) High marks were awarded for definitions/explanations of crop spacing and density and detailed discussions of the influence these have on plants e.g. on size, shape, quality, time to maturity/harvest. High marks were also awarded for considerations of weed control, marketable yield, optimum populations and pest and disease control as influenced by spacing and density.

Q4 a) Define **EACH** of the following common types of seed dormancy:

v) innate;
vi) induced;
vii) enforced;
viii) double/delayed.

b) Describe **ONE** method of breaking dormancy for **EACH** of the types defined in a) and give a **NAMED** example in each case.

The aim of the question is to assess whether candidates can distinguish the different types of dormancy accurately, by providing precise definitions of each type. High marks were awarded for concise, accurate definitions. E.G.

a) Innate dormancy is under genetic control, but is influenced by the environmental conditions during seed maturation e.g. immature embryos; whilst, in enforced dormancy the seeds are capable of germination but are prevented from doing so by the immediate environmental condition such as lack of water, inappropriate temperature range, etc.

b) High marks were awarded for accurate and pertinent dormancy breaking methods relevant to an appropriately named example in each case.

Examples of innate dormancy include immature embryos in Carrots, Daucus carota, which can be avoided by harvesting fully mature seed and appropriate mother plant nutrition; or as in hard seeds 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.

Q5 a) Describe how the vegetative and reproductive stages of a **NAMED** plant are affected by the manipulation of the photoperiod.

b) Explain the importance of **EACH** of the following:

iv) critical day length;
v) plant response group;
vi) photo-inductive cycles.

The aim of the question is to assess whether candidates were able to accurately describe how, by manipulating photoperiod, named plants may be switched from vegetative to reproductive phase or indeed maintained at a particular phrase for a specified period of time. The aim of the second part of the question was to distinguish key terms used in any discussion of photoperiod.

High marks were awarded for an accurate description of the effect of photoperiod on e.g. Poinsettias
Poinsettias have a critical daylength of around 12 hrs (11-12.5). Otherwise they remain vegetative. Plants will flower after about 10 weeks of short days. Under natural conditions they will initiate flowers towards the end of Sep and flower too early for Christmas. Supplementary lighting is required for 2-3 weeks to ensure that bracts colour well in time. Year round production requires the use of lighting from mid-September to mid March. A minimum of 100 lux is required for 4h in the middle of the night.

High marks were awarded for an accurate explanations e.g. a photoperiodic cycle that induces the initiation of flowers is called a photo-inducive cycle. A 10 hr photoperiod alternating with a 14-hr dark period is one possible photo-inducive cycle of a short-day cultivar. High marks were awarded if this was followed by a discussion of examples of other photo-inductive cycles.

Q6 Explain how **NAMED** plant growth regulators are used in **EACH** of the following:

v) fruit set and parthenocarpy;
vi) fruit storage and ripening;
vii) propagation by tissue culture;
viii) a pot chrysanthemum crop.

The aim of this question is to ascertain the role of a range of PGRs on a number of different physiological conditions.
High marks were awarded for detailed explanations of the mode of action of appropriately named PGRs in the various contexts. In fruit set and parthenocarpy high marks were awarded for an explanation of Parthenocarpy being the development of a fruit without prior fertilization. This is a useful phenomenon when the object of the crop is the production of seedless fruit, as in cucumber. Parthenocarpy is usually accompanied by a high level of auxin in the plant. Parthenocarpy may be induced in pears by a spray of gibberelic acid. Also cytokinin together with auxin & gibberellins can promote parthenocarpy.

In propagation by tissue culture for example high marks were awarded for a

thorough explanation of the role of cytokinins and auxins and the effect of the relative concentrations of these on propagule growth. High marks were given for a consideration of the other PGRs which could also be used in tissue culture i.e. ABA and to a lesser extent GA3.

For the last section of the question, high marks were attributed for clear explanations for the use of plant growth regulators for pot chrysanthemums. A named chrysanthemum, (chrysanthemum x marifolium 'Cassandra'), together with other cultivars are grown as 'dwarf pot mums'. The use of auxins at the correct levels assist the production of fibron roots with a uniform root system. NAA produces good root system but stunting may occur; therefore a mix of 50/50 powder or liquid drip of IBA can be used.

The use of anti-gibberellins at the start, is to prevent the effect of natural endogenous gibberellins and where cuttings are dipped into either Paclobutrazol or Darrinozide prior to 'sticking'. Plants are sprayed at key stages of vegetative growth in order to ensure the plant growth regulator enters the plant via terminal or lateral buds.

The aim is to achieve shorter internodes and therefore thicker stems, which will support the inflorescence.

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