RHS LEVEL 3 DIPLOMA IN HORTICULTURE
WRITTEN EXAMINATION

2:00pm Thursday 8th July 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 the function of **EACH** of the following terms:

i) nuclear envelope;
ii) chromatin. **2**

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Q2 State **TWO** practical uses of herbaria to horticulture. **2**

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Q3 a) State what is meant by the term ‘open pollinated populations’ in the context of plant breeding.

b) State **ONE** reason why this may not be an effective method of plant breeding. **2**

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Please see over/…..

ANSWER ALL QUESTIONS

MARKS

Q4 State **TWO** horticultural uses for plants in the family ***Poaceae***, providing a **NAMED** example in **EACH** case. **2**

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Q5 Distinguish between ‘growth’ and ‘development’ in plants. **2**

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Q6 Explain the role of phytochrome in seed germination. **2**

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Q7 Define the term ‘crop spatial arrangement’. **2**

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ANSWER ALL QUESTIONS

MARKS

Q8 Explain why the elimination of weeds is normally adopted in order to achieve maximum crop yields. **2**

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Q9 State the significance of physiological age in the development of plants. **2**

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Q10 Identify the **TWO** plant hormones responsible for stem extension and state the mode of action for **EACH**. **2**

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RHS LEVEL 3 DIPLOMA IN HORTICULTURE
WRITTEN EXAMINATION

2:00pm Thursday 8th July 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) A breeding programme was set up with the aim of selecting tall plants with green flowers, by crossing pure lines of tall plants with white flowers, and dwarf plants with green flowers (dominant genes tall and white). Explain the stages in the breeding process including the:

i) production of the F_1 hybrid; **4**

ii) resultant phenotype and genotype of the F_1 generation; **2**

iii) punnet square to demonstrate the resulting genotypes and phenotypes of the F_2 generation. **6**

b) If 480 F_2 plants were raised, calculate the expected numbers of tall plants with green flowers. **2**

c) Demonstrate how the breeder would identify the homozygous tall plants with green flowers using a test cross. **6**

Q12 a) State what is meant by the term 'plant genetic modification' (GM). **2**

b) Review any public concerns associated with growing GM crops. **10**

c) Describe **FOUR** benefits of genetically modified plants using **NAMED** horticultural examples. **8**

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Please see over/…..

Section C – Plant Physiology II

Answer TWO questions from this section

MARKS

Q13 a) State **TWO** differences between endogenous and synthetic plant growth regulators. **6**

b) Explain why, for synthetic plant growth regulators, synergy and antagonism are important in:

i) physical plant responses;
ii) the selection for use in commercial plant production. **8**

c) State the principal role of the plant growth regulators commonly used in tissue culture (meristem culture). **6**

Q14 a) Explain why crops grown under protection can provide higher yields, compared to the same crop grown outside. **10**

b) Review how growers can improve the quality of plants **OR** crops grown under protective structures. **10**

Q15 a) Explain how fruit set can be modified by the application of **NAMED** synthetic plant growth regulators. **6**

b) Review the influence of ethylene in the production of plants grown under protection. **8**

c) Explain the value of **TWO NAMED** synthetic plant growth regulators to achieve premature leaf fall in hardy nursery stock. **6**

Please turn over/…..

Section C – Plant Physiology II

Answer TWO questions from this section

MARKS

Q16 a) Review the use of pesticides in the production of plants under **EACH** of the following headings:

i) benefit of pesticides;
ii) hazards to personnel,
iii) potential harm to plants. **12**

b) Explain how **FOUR** problems identified in a) ii and a) iii, can be managed safely. **8**

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RHS LEVEL 3 DIPLOMA IN HORTICULTURE
WRITTEN EXAMINATION

2:00pm Thursday 8th July 2010

MODULE G

Genetics, Plant Breeding & Systematic Botany
Plant Physiology II

Candidates Registered	**32**		**Total Candidates Passed**	**25**	**89.29%**
Candidates Entered	28	87.5%	Passed with Commendation	4	14.29%
Candidates Absent	2	6.25%	Passed	21	75.00%
Candidates Deferred	1	3.13%	Failed	3	10.71%
Candidates Withdrawn	1	3.13%			

Section A – Short Answer Questions

Q1 State the function of **EACH** of the following terms:

i) nuclear envelope;
ii) chromatin.

This question was satisfactorily answered. High marks were awarded for answers that stated that the nuclear envelope is a double-layered membrane that encloses the contents of the nucleus. It has nuclear pores - large holes containing proteins that control the exit of substances such as RNA and ribosomes from the nucleus. High marks were awarded for answers that stated that chromatin is a DNA/protein complex in a 1:2 ratio, containing the genes

Q2 State **TWO** practical uses of herbaria to horticulture.

This question was well answered. High marks were awarded for answers that stated that herbaria are used by botanists for the identification and classification of plants and they also provide a historical record of what was growing in a particular place at a particular time, amongst other points.

Q3 .a) State what is meant by the term ‘open pollinated populations’ in the context of plant breeding.

b) State **ONE** reason why this may not be an effective method of plant breeding.

This question was satisfactorily answered. There was some confusion over the term 'open pollinated populations' in that explanations of this term were not precise. High marks were awarded for answers that stated that an 'open pollinated population' is an outbred population in which pollination is uncontrolled. This may not be an effective method of plant breeding as the assortment of alleles is too random resulting in a variable population.

Q4 State **TWO** horticultural uses for plants in the family ***Poaceae***, providing a **NAMED** example in **EACH** case.

This question was well answered. High marks were awarded for answers that named appropriate horticultural food crops and amenity plants.

Q5 Distinguish between ‘growth’ and ‘development’ in plants.

This question was satisfactorily answered. High marks were awarded for answers that clearly distinguished between 'growth' and 'development' in plants. 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.

Q6 Explain the role of phytochrome in seed germination.

This question was satisfactorily answered though some answers described the role of phytochrome without mentioning seed germination. High marks were awarded for answers that explained that far red light strongly inhibits seed germination and seed germination is stimulated by red light.

Q7 Define the term ‘crop spatial arrangement’.

This question was satisfactorily answered. High marks were awarded for answers that provided a precise definition i.e. that crop spatial arrangement is the interaction between population density, distance between plants (row spacing) and the angular arrangement of plants about one another.

Q8 Explain why the elimination of weeds is normally adopted in order to achieve maximum crop yields.

This question was well answered. High marks were awarded for answers that explained the interrelationship between weeds and yield. Weeds compete with crops for scarce resources i.e. water, sunlight, fertilisers etc thereby reducing yield.

Q9 State the significance of physiological age in the development of plants.

This question was unsatisfactorily answered. Candidates did not state the significance of physiological age but instead described plant life cycles. High marks were awarded for answers that stated that physiological age is characterised by leaf number. A minimum of which has to be reached before a plant changes from the juvenile to the adult (reproductive) form.

Q10 Identify the **TWO** plant hormones responsible for stem extension and state the mode of action for **EACH**.

This question was satisfactorily answered. High marks were awarded for answers that identified auxin and gibberellin and stated their respective modes of action.

Sections B & C – Structured Questions

Section B - Genetics, Plant Breeding & Systematic Botany

Q11 a) A breeding programme was set up with the aim of selecting tall plants with green flowers, by crossing pure lines of tall plants with white flowers, and dwarf plants with green flowers (dominant genes tall and white). Explain the stages in the breeding process including the:

i) production of the F_1 hybrid;

ii) resultant phenotype and genotype of the F_1 generation;

iii) punnet square to demonstrate the resulting genotypes and phenotypes of the F_2 generation.

b) If 480 F_2 plants were raised, calculate the expected numbers of tall plants with green flowers.

c) Demonstrate how the breeder would identify the homozygous tall plants with green flowers using a test cross.

The aim of this question was to allow candidates to describe a plant breeding technique, in this example the production of F_1 hybrids, determine the genotype and phenotype of F_1 and F_2 results from a di - hybrid cross without gene linkage and explain the process of a back cross (test cross).

Many candidates were able to demonstrate their knowledge of techniques involved in the production of F_1 hybrids such as creation of pure lines by inbreeding for several generations, reducing the chances of selfing by emasculation, using introduced insect pollinators or hand pollinating to transfer pollen from pollen parent to seed parent, excluding all other sources of pollen and pollinators.

The F_1 hybrid produced by crossing the two homozygous parent lines was a tall, white flowered plant exhibiting both dominant characteristics with the genotype TtWw, where T is dominant allele for tallness, t is recessive allele for dwarfness, and W is dominant allele for white flowers and w is recessive allele for green flowers.

Most candidates were able to construct a punnet square with the gametes produced from the F_1 plants being TW, Tw, tW and tw.

	TW	tW	Tw	tw
TW	TTWW	TtWW	TTWw	TtWw
tW	TtWW	ttWW	TtWw	ttWw
Tw	TTWw	TtWw	TTww	Ttww
tw	TtWw	ttWw	Ttww	ttww

The resulting F_2 phenotype ratios could then be interpreted as 9 plants tall with white flowers, 3 plants tall with green flowers, 3 plants dwarf with white flowers and 1 plant dwarf with green flowers.

In the second part of the question, the aim of the breeding programme was to select tall plants with green flowers, so for every 16 plants produced, the expectation would be that 3 of the 16 would be tall with green flowers. For 480 plants 3/16 of these plants, that is 90 plants, would be expected to be tall with green flowers.

In the third part of the question all the tall plants with green flowers will be homozygous for the gene for green flowers as this is a recessive characteristic. However they may be heterozygous with two differing alleles for the tall gene. All the tall plants with green flowers should be back crossed individually to the recessive pure line parent i.e. to the dwarf plant with green flowers.

Homozygous plant TTww x pure line ttww
Gametes TW and tw
F_1 all offspring Ttww and all plants tall with green flowers
This backcross (test cross) identifies the homozygous tall plants with green flowers.

Heterozygous plant Ttww x pure line ttww
Gametes Tw or tw and tw
F_1 50%Ttww 50% ttww
Half plants are tall with green flowers; half are dwarf with green flowers
This back cross identifies the heterozygous plants.

The recommendations for candidates attempting this question are to read the question carefully making note of the dominant genes, to use the accepted notation for dominant and recessive alleles and to note the allocation of the marks between the different sections of the question and allocate their time and detail of answer accordingly.

Q12 a) State what is meant by the term 'plant genetic modification' (GM).

b) Review any public concerns associated with growing GM crops.

c) Describe **FOUR** benefits of genetically modified plants using **NAMED** horticultural examples.

The aims of this question were for candidates to review the major advantages and disadvantages of the genetic modification of plants in relation to public perception of the potential concerns and also to identify recognised benefits of genetically modified plants in relation to named horticultural examples.

Candidates gave a variety of interpretations of the term 'plant genetic modification' from the broadest definition which covered the whole of plant selection and breeding techniques to the more invasive procedures of introduction and manipulation of DNA. Higher marks were awarded to the definition which included the modification of the plant's genome (DNA) by introduction of specific genes from a related or unrelated organism.

Candidates were able to describe and set in context public concerns about the possible environmental, ethical, economic and biological implications of growing GM crops. Highest marks were given to the most comprehensive reviews of public concerns which included:

- potential synthesis of undesirable compounds or allergens which could enter the food chain,
- possible long term cumulative/chronic effect on consumers,
- escape of recombinant DNA via pollen transfer into native populations (gene flow),
- potential risk of release of marker genes, usually herbicide or antibiotic resistance into the wider plant population,
- reduction of biodiversity from widespread use of GM crops containing insecticide producing gene,
- selection pressure on insect pest populations,
- unknown effect on pollinators and other animals in the food chain/food web
- loss of land races,
- use of terminator gene prevents seed saving,
- profit making by large multinational organisations at expense of third world producers and
- scientists usurping role of natural creator and evolution.

The third section of the question was interpreted very broadly but highest marks were given to candidates who named horticultural examples of plants which had been genetically modified for the benefit of consumer or producer. Lower marks were given for agricultural examples of GM crops and also for improved horticultural plants obtained by selection or hybridisation or other non invasive techniques.

Section C – Plant Physiology II

Q13 a) State **TWO** differences between endogenous and synthetic plant growth regulators.

b) Explain why, for synthetic plant growth regulators, synergy and antagonism are important in:

i) physical plant responses;
ii) the selection for use in commercial plant production.

c) State the principal role of the plant growth regulators commonly used in tissue culture (meristem culture).

The first part of the question was satisfactorily answered. High marks were awarded for answers that stated clear differences between endogenous and synthetic plant growth regulators, e.g. synthesis of endogenous plant hormones may be localised or found in a range of plant tissue whilst synthetic plant growth regulators usually target specific organs, endogenous plant growth regulators are less stable than synthetic plant growth regulators.

The second part of the question was not well answered. High marks were awarded for explanations of the terms synergy and antagonism with relevant examples e.g. auxin and gibberellin combined bring about greater internode elongation, antagonism can either be additive but opposite or suppress the action of a PGR e.g auxin and cytokinin in apical dominance, antagonistic relationship between ABA and GA4 in seed dormancy, auxin induced ethylene production to induce flowering in pineapples.

The final part of the question was not well answered. High marks were awarded for statements which included all the PGRs used in tissue culture, not just auxins and cytokinins.

Q14 a) Explain why crops grown under protection can provide higher yields, compared to the same crop grown outside.

b) Review how growers can improve the quality of plants **OR** crops grown under protective structures..

The first part of the question was satisfactorily answered. High marks were awarded for comparisons between a crop grown under protection and the same crop grown outside.

The second part of the question was not well answered. High marks were awarded for a detailed review of how plant / crop quality may be improved under protective cropping and not the merits of protective cropping ***per se.***

Q15 a) Explain how fruit set can be modified by the application of **NAMED** synthetic plant growth regulators.

b) Review the influence of ethylene in the production of plants grown under protection.

c) Explain the value of **TWO NAMED** synthetic plant growth regulators to achieve premature leaf fall in hardy nursery stock.

The first part of the question was satisfactorily answered. High marks were awarded for answers that explained the use of the following: GA in grapes, 4-CPA in tomatoes, NAA in pineapples (auxin induced ethylene production)

The second part of the question was satisfactorily answered. High marks were awarded for answers that reviewed the following:
ethylene stimulates senescence and thus affects abscission of leaves and fruit, inhibits the growth of some plants, promotes flowering in pineapples including ornamental types, and in some cases releases vegetative buds from dormancy.

The final part of the question was satisfactorily answered. High marks were awarded for answers that explained premature leaf fall e.g. ethephon promotes earlier defoliation on rose and apple nursery stock, and why this is of benefit to the industry.

Q16 a) Review the use of pesticides in the production of plants under **EACH** of the following headings:

i) benefit of pesticides;
ii) hazards to personnel,
iii) potential harm to plants.

b) Explain how **FOUR** problems identified in a) ii and a) iii, can be managed safely.

This question was well answered. In part i), high marks were awarded for answers that included the following:

- without these important products, food production would decline. Crop productivity has increased anywhere between 20 and 50% with the use of pesticides,
- pesticides allow farmers to maximise the benefits of other inputs, which include high quality seeds, fertilizers, and precious water resources,
- pesticides make possible the year-round availability of high-quality, affordable food.

In part ii) technically there should be no hazards to personnel if the product is used as per label instructions. These points should be reviewed:

- a definition of hazard should be provided with a list of the hazards posed to personnel,
- handling concentrate vs dilutions,
- insecticides are potentially more hazardous than fungicides and herbicides as they are neurological poisons.

Current legislation should be cited e.g. Health and Safety at work Act, Food ,Environment Protection Act and COSHH and Poisons Act

In part iii) the following should be included in answers:

- the effect of over dosage,
- effect of inappropriate selection of pesticide,
- effect of spraying at critical growth stages i.e. too early or too late,
- effect of inappropriate tank mixes,
- spraying in inappropriate weather esp. low temperatures,
- specific products are formulated for specific plant groups and there is possible harm to plants of off label use.

In part b high marks were awarded for detailed explanations of any FOUR problems indentified in a) ii) and a) iii). e.g. use of appropriate PPE, the value of education and full knowledge of the products being handled, appropriate certification and licence to handle chemicals, i.e. BASIS qualified.