

**UNIVERSITY OF FORT HARE**

**AGC413**

**SUPPLEMENTARY EXAMINATIONS**

**August**

**2018**

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**Time: 3 Hours**

**Subject: Principles of genetics and plant breeding**

**Marks: 100**

**This paper consists of 6 pages including the cover page**

**Internal Examiners**

**Prof CS Mutengwa  
Prof IK Mariga**

**INSTRUCTIONS**

**Answer any FIVE (5) questions**

**Question one (20 marks)**

a) In tomato, the occurrence of red flowers (R) is dominant to white flowers (r). Determinate growth habit (d) is recessive to an indeterminate growth habit (D). A double heterozygous plant was test-crossed with a double recessive one with the following genotype, rd/rd. The following progeny were produced.

Phenotypes	Frequency
Red flowered; determinate (Rd)	500
Red flowered; indeterminate (RD)	115
White flowered; determinate (rd)	120
White flowered; indeterminate (rD)	490

Calculate the percentage recombination between "R" and "D", indicate the linkage distance between them, and then discuss the linkage relationship between these two genes. [6]

b) Write short notes on the following mechanisms of disease resistance.

- i) Mechanical resistance [3]
- ii) Nutritional resistance [3]

c) Write short notes on "Choice of parents", which is an important step in the procedure of hybridisation. [4]

d) Define the term 'emasculatation' and list three methods that can be used to accomplish this practice. [4]

**Question two (20 marks)**

(a) Define the following terms.

- i) autopolyploid". [1]
- ii) Race-specific resistance [2]
- iii) Horizontal resistance [2]

b) List any five limitations of mutation breeding. [5]

c) Elaborate on the importance of creating disease epiphytotics when breeding crops for disease resistance. [4]

d) Indicate how the following types of aneuploids are produced. [4]

(i) monosomic

(ii) trisomic

e) Why is use of genetic male sterility in seed production limited? [2]

**Question three (20 marks)**

a) What are some of the advantages of using transformation techniques in plant breeding? [3]

b) List, in their sequential order, the five steps that are followed as part of the procedure for mutation breeding. [5]

c) Based on the gene-for-gene relationship that was postulated by Flor in 1956, explain why a susceptible response will be observed when a pathogen attacks a given host. [2]

d) Explain why a cross between a cytoplasmic male sterile female and a male fertile male will produce all male sterile progeny. [2]

e) Write short notes on combination breeding, which is one of the objectives of hybridization. [5]

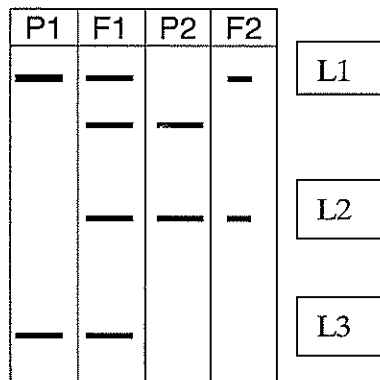
f) Define the following: (i) LD50; (ii) Mutagenesis; (iii) Macromutation [3]

**Question four (20 marks)**

a) What do the following acronyms stand for: i) RFLP; ii) SSR; iii) RAPD. [3]

b) State the causes of genetic variation between genotypes when one is working with each of the above markers. [3]

c) Below is a schematic gel in which lanes are indicated by vertical lines. It is the picture obtained from amplifying a segregating F<sub>2</sub> population with parents (P<sub>1</sub> and P<sub>2</sub>), F<sub>1</sub> (P<sub>1</sub> × P<sub>2</sub>), and one F<sub>2</sub> individual (F<sub>1</sub> × F<sub>1</sub>). Also depicted are three marker loci (L<sub>1</sub> – L<sub>3</sub>) resulting from using polymerase chain reaction (PCR) based techniques. Marker L<sub>1</sub> is codominant, while markers L<sub>2</sub> and L<sub>3</sub> are dominant.



Determine the genotypes for the F1 and the F2 individual for markers L1, L2 and L3. Indicate genotypes in the table below. Genotypes of both parents are already given as an example. [6]

	P1	F1	P2	F2
L1	AA		aa	
L2	aa		AA	
L3	AA		aa	

d) Triticale arose from a cross between wheat and rye. Use a flow diagram to illustrate how this allopolyploid species arose. [5]

e) What are the genetic consequences of cross-pollination? [3]

**Question five (20 marks)**

In fruit flies, a cross was made between females which were heterozygous for the genes harsh bristles (ha), thick eyes (t) and round body (r), and males which were completely recessive for all the three genes. When a sample of the offspring were counted, the following results were obtained:

<u>Phenotype</u>	<u>Offspring</u>
a r q	470
+ + +	485
+ r q	220
a + +	245
a + q	30
+ r +	35
a r +	5
+ + q	10

- a) Which progeny classes are the parental types? [2]
- b) Which progeny classes are the double recombinant types? [2]
- c) What is the sequence of the genes? [4]
- d) Calculate the map distances between the genes, and draw a linkage map of these loci. [6]
- e) Determine the coefficient of coincidence and also calculate interference for these loci. [4]
- f) i) Why are restriction enzymes referred to as endonucleases? [1]
- ii) How does a bacterial strain producing a certain restriction enzyme protect its own DNA from being degraded by the same restriction enzyme?" [1]

**Question six (20 marks)**

- a) Explain why a "selectable marker" is essential when producing recombinant DNA molecules? [2]
- b) Explain why *Agrobacterium tumefaciens* is referred to as a natural genetic engineer? [3]
- c) Why is reference to transgenic plants as genetically modified organisms (GMOs) misleading? [2]
- d) Define self-incompatibility and elaborate on its applications in plant breeding. [3]
- e) Apart from their use in marker assisted selection (MAS), list five other uses of molecular markers [5]
- f) Which tissue culture technique enables you to do the following? [5]

<b>Characteristics</b>	<b>Tissue culture technique</b>
1. Eliminate viruses from plant selections	
2. Produce haploid plants that contain only one copy of each chromosome	
3. Enables production of dihaploids	
4. Unite cells and subsequently regenerate them into whole plants	
5. Regenerate a complete new plant from meristems (growing tips)	