UNIVERSITY OF SWAZILAND

SUPPLEMENTARY EXAMINATION PAPER: JUNE 2008

TITLE OF PAPER: GENETICS

COURSE CODE: B303

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:
1. ANSWER QUESTION 1 (COMPULSORY) IN SECTION A AND ANY THREE OTHER QUESTIONS IN SECTION B.
2. EACH QUESTION CARRIES TWENTY FIVE (25) MARKS.
3. ILLUSTRATE YOUR ANSWERS WITH LARGE AND CLEARLY LABELLED DIAGRAMS WHERE APPROPRIATE.
4. ALL WORKINGS MUST BE CLEARLY SHOWN.

SPECIAL REQUIREMENTS: CANDIDATES MAY BRING CALCULATORS

THIS PAPER IS NOT TO BE OPENED UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATORS

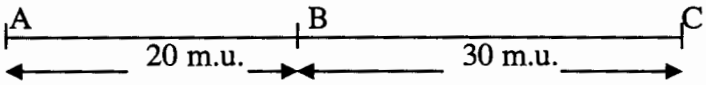
SECTION A (COMPULSORY)

Question 1

(a) From the phenotype data for two 3-point testcrosses 1 and 2 given in the table below for genes *a*, *b*, *c* and *d*, determine the map distances between them. Recessive phenotypes are symbolised by lowercase letters and dominant phenotypes by plusses. (10 marks)

1		2	
+ + +	669	*b c d*	8
a b +	139	*b* + +	441
a + +	3	*b* + *d*	90
+ + *c*	121	+ *c d*	376
+ *b c*	2	+ + +	14
a + *c*	2280	+ + *d*	153
a b c	653	+ *c* +	65
+ *b* +	2215	*b c* +	141

(b) In a certain diploid plant, the three loci A, B, and C are linked as shown below. One parental plant available to you has the constitution *A b c/a B C*.



Assuming no interference,

(i) Calculate the proportion of the progeny that will be of genotype *a b c/a b c* if the plant is selfed. (5 marks)

(ii) Determine the genotypic classes that will be found in the progeny if the parental plant is crossed with *a b c/a b c* plant. (5 marks)

(iii) Calculate gene frequencies in (ii) above if there are 1000 progeny. (5 marks)

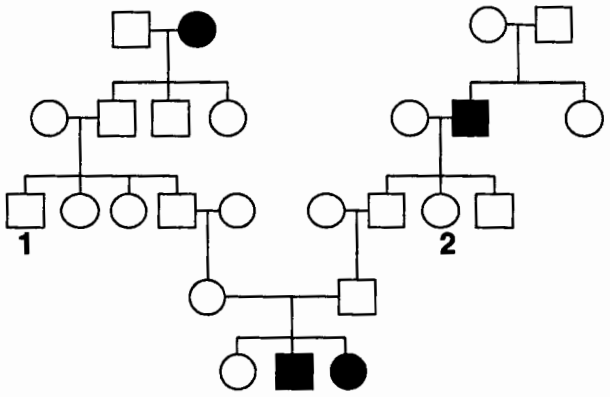
[TOTAL MARKS = 25]

SECTION B (ATTEMPT ANY THREE QUESTIONS FROM THIS SECTION)

Question 2

(a) Distinguish between intergenic and intragenic complementation. (6 marks)

(b) The pedigree shown below was obtained for a rare kidney disease.



(i) Deduce the inheritance of this condition stating your reasons. (5 marks)
(ii) If individuals 1 and 2 intermarry, calculate the probability that their first child will have a kidney disease. (4 marks)

(c) Outline the special uses of ordered tetrads in genetic analysis. (10 marks)

[TOTAL MARKS = 25]

Question 3

(a) Give precise descriptions of genetic and cytological features that identify and characterise the following:
(i) deletions; (4 marks)
(ii) duplications; (4 marks)
(iii) inversions; (4 marks)
(iv) reciprocal translocations. (4 marks)

(b) The two loci P and Q are normally 36 m.u. apart on the same arm of a certain plant chromosome. A paracentric inversion spans about a quarter of this region but does not include either loci. Predict approximate recombinant frequency for these loci in plants that are:
(i) heterozygous for the paracentric inversion; (2 marks)
(ii) homozygous for the paracentric inversion. (2 marks)

(c) Explain two ways in which you could make an allotetraploid between two related diploid plant species $2n = 28$. (5 marks)

[TOTAL MARKS = 25]

Question 4

(a) Transposable elements have been referred to as 'jumping genes' because they appear to jump from one position to another, leaving the old locus and appearing at a new locus. In light of this, critique the appropriateness of the term 'jumping genes' for bacterial transposable elements. (5 marks)

(b) Many mutagens increase the frequency of sister chromatid exchange. Give possible explanations for this observation. (4 marks)

(c) Examine the following ascus pattern and investigate the linear asci(us) that show(s) gene conversion at the *arg* locus. (6 marks)

1	2	3	4	5	6
+	+	+	+	+	+
+	+	+	+	+	+
+	*arg*	+	+	*arg*	*arg*
+	*arg*	*arg*	*arg*	*arg*	*arg*
arg	*arg*	*arg*	+	+	*arg*
arg	*arg*	*arg*	*arg*	+	*arg*
arg	+	*arg*	*arg*	*arg*	*arg*
arg	+	*arg*	*arg*	*arg*	*arg*

(d) Discuss the generation of multiple drug-resistance plasmids. (10 marks)

[TOTAL MARKS = 25]

Question 5

(a) In yeast, you have sequenced a piece of wild-type DNA and it clearly contains a gene, but you do not know what gene it is. Therefore, to investigate further, you would like to find out its mutant phenotype. Outline how you would use the cloned wild-type gene to do this. Show your experimental steps clearly. (10 marks)

(b) Two different circular yeast plasmid vector (YP1 and YP2) were used to transform *leu*$^+$ cells into *leu*$^-$. The resulting *leu*$^+$ cultures from both experiments were crossed with the same *leu*$^-$ cell of opposite mating type. Typical results were as follows:

YP1 *leu*$^+$ x *leu*$^-$ ➔ all progeny *leu*$^+$ and the DNA of all these progeny showed positive hybridization to a probe.

YP2 *leu*$^+$ x *leu*$^-$ ➔ 50% progeny *leu*$^+$ and hybridise to vector probe specific to YP2; 50% progeny *leu*$^-$ and do not hybridise to YP2 probe.

(i) Explain the different action of these two plasmids during transformation. (6 marks)

(ii) If total DNA is extracted from transformants from YP1 and YP2 and digested with an enzyme that cuts once within the vector (and not the insert), predict the results of the electrophoresis and Southern analyses of the DNA. (9 marks)

[TOTAL MARKS = 25]

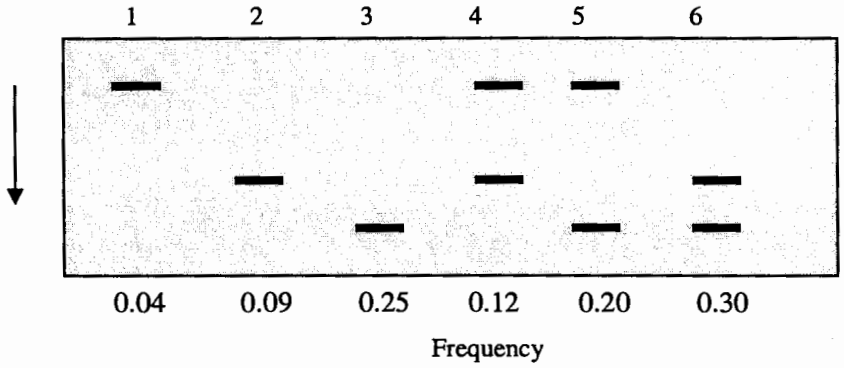
[PLEASE TURN OVER]

Question 6

(a) Outline the forces that change the frequency of an allele in a population. (5 marks)

(b) In a large experimental *Drosophila* population, the fitness of a recessive phenotype is calculated to be 0.90, and the mutation rate to the recessive allele is 5×10^{-5}. If the population is allowed to come to equilibrium, predict the allelic frequencies. (5 marks)

(c) In a large natural population of *Mimulus guttatus*, one leaf was sampled from each of a large number of plants. Leaves were crushed and subjected to gel electrophoresis. The gel was then stained for a specific enzyme Q. Six different patterns were observed as shown in the diagram below.



(i) Assuming that these patterns are produced by single locus, propose a genetic explanation for the six types. (3 marks)
(ii) Briefly explain how you could test your idea in (i) above. (2 marks)
(iii) Calculate the allelic frequencies in this population. (5 marks)
(iv) Investigate if the population is in Hardy-Weinberg equilibrium. (5 marks)

[TOTAL MARKS = 25]

[END OF QUESTION PAPER]