UNIVERSITY OF SWAZILAND

SUPPLEMENTARY EXAMINATION PAPER: JULY 2016

TITLE OF PAPER: GENETICS

COURSE CODE: B303

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:
1. THIS PAPER IS DIVIDED INTO TWO SECTIONS
2. ANSWER QUESTION 1 (COMPULSORY) IN SECTION A AND ANY THREE OTHER QUESTIONS IN SECTION B
3. EACH QUESTION CARRIES TWENTY FIVE (25) MARKS
4. ILLUSTRATE YOUR ANSWER WITH LARGE AND CLEARLY LABELLED DIAGRAMS WHERE APPROPRIATE

SPECIAL REQUIREMENTS: CANDIDATES MAY BRING CALCULATORS

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

SECTION A (COMPULSORY)

Question 1

(a) Explain the chromosome theory of inheritance and how is it related to Mendel's findings. (5 marks)

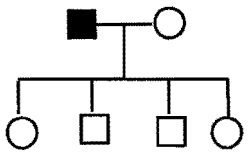
(b) During meiosis, when does *chromosome* disjunction occur? When does *chromatid* disjunction occur? (5 marks)

(c) A woman has a rare abnormality of the eyelids called ptosis, which prevents her from opening her eyes completely. This condition is caused by a dominant allele, *P*. The woman's father had ptosis, but her mother had normal eyelids. Her father's mother had normal eyelids.

(i) What are the genotypes of the woman, her father, and her mother? (3 marks)

(ii) What proportion of the woman's children will have ptosis if she marries a man with normal eyelids? (2 marks)

(d) A man with a specific unusual genetic trait marries an unaffected woman and they have four children. Shown below is a pedigree of this family where the presence or absence of the trait in the children is not indicated.



For each type of inheritance numbered (i) to (v), indicate how many children of each sex are expected to express the trait by re-drawing and filling in the appropriate circles and squares. Assume that the trait is rare and fully penetrant.

(i) Autosomal recessive trait (2 marks)
(ii) Autosomal dominant trait (2 marks)
(iii) X-linked recessive trait (2 marks)
(iv) X-linked dominant trait (2 marks)
(v) Y-linked trait (2 marks)

[Total 25 marks]

SECTION B (ANSWER ANY THREE QUESTIONS FROM THIS SECTION)

Question 2

(a) A snap dragon plant that bred true for white petals was crossed to a plant that bred true for purple petals, and all the F1 had white petals. The F1 was selfed. Among the F2, three phenotypes were observed in the following numbers: white 240 solid purple 61, spotted purple 19.

(i) Explain these results, showing genotypes of all generations. (15 marks)

(ii) A white F2 plant was crossed to a solid purple F2 plant, and the progeny were: white 50%, solid purple 25% and spotted purple 25%. Deduce the genotypes of the F2 plants crossed. (10 marks)

[Total = 25 marks]

Question 3

(a) In human beings, the gene for β-globin is located on chromosome 11, and the gene for α-globin, which is another component of the hemoglobin protein, is located on chromosome 16. Would these two chromosomes be expected to pair with each other during meiosis? Explain. (3 marks)

(b) In rabbits, the dominant allele *B* causes black fur and the recessive allele *b* causes brown fur; for an independently assorting gene, the dominant allele ***R*** causes long fur and the recessive allele ***r*** causes short fur. A homozygous rabbit with long, black fur is crossed with a rabbit with short, brown fur, and the offspring are intercrossed. In the F_2, what proportion of the rabbits with long, black fur will be homozygous for both genes? (9 marks)

(c) Mendel testcrossed pea plants grown from yellow, round F_1 seeds to plants grown from green, wrinkled seeds and obtained the following results: 30 yellow, round; 25 green, round; 28 yellow, wrinkled; and 27 green, wrinkled. Are these results consistent with the hypothesis that seed color and seed texture are controlled by independently assorting genes, each segregating two alleles? (13 marks)

[Total = 25 marks]

Question 4

(a) Briefly discuss common misunderstandings or misapplications of the concept of heritability. (10 marks)

(b). Assume that three loci, each with two alleles (*A* and *a*, *B* and *b*, *C* and *c*), determine the differences in height between two homozygous strains of a plant. These genes are additive and equal in their effects on plant height. One strain (*aabbcc*) is 10 cm in height. The other strain (*AABBCC*) is 22 cm in height. The two strains are crossed, and the resulting F_1 are interbred to produce F_2 progeny. Give the phenotypes and the expected proportions of the F_2 progeny. (15 marks)

[Total = 25 marks]

Question 5

The table below shows the phenotype data for two 3-point testcrosses A and B for genes *a*, *b*, *c* and *d*. Recessive phenotypes are symbolized by lowercase letters and dominant phenotypes by plusses (+).

A		B	
+ + +	670	*b c d*	8
a b +	140	*b* + +	440
a + +	6	*b* + *d*	90
+ + *c*	120	+ *c d*	375
+ *b c*	4	+ + +	12
a + *c*	2280	+ + *d*	150
a b c	650	+ *c* +	65
+ *b* +	2215	*b c* +	145
TOTAL	6085		1285

(a) Using recombinant frequencies determine the map distances between all the genes and represent such distances on a genetic map. (18 marks)

(b) Estimate the genetic interference in cross A. (7 marks)

Question 6

(a) What is the purpose of Southern blotting? How is it carried out? (3 marks)

(b) Give three important characteristics of cloning vectors. (3 marks)

(c) How are plasmids transferred into bacterial cells? (3 marks)

(d) How does a genomic library differ from a cDNA library? (3 marks)

(f) Discuss some of the considerations that must go into developing an appropriate cloning strategy. (3 marks)

(f) Briefly explain how the polymerase chain reaction is used to amplify a specific DNA sequence. What are some of the limitations of PCR? (10 marks)

[Total 25 marks]

END OF QUESTION PAPER