UNIVERSITY OF SWAZILAND

FINAL EXAMINATION PAPER: DECEMBER 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)

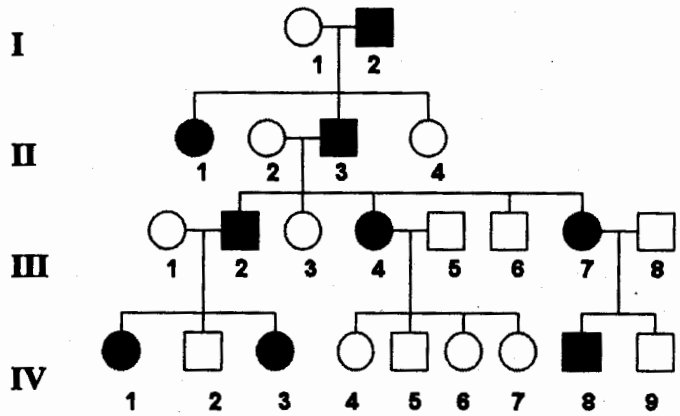
Question 1

(a) Distinguish between a genetic map and a physical map. (2 marks)

(b) Using the data below, sketch the genetic map for the alleles A, B, C and D. (8 marks)

Gene pair	*Recombinant frequency*
A and D	8
B and D	13
C and D	23

(c) Consider the following pedigree for a rare, but relatively mild, hereditary skin disorder and choose your own defined allelic symbols.



(i) Deduce the pattern of inheritance displayed, i.e. whether the disorder is inherited as a dominant or recessive phenotype, giving reasons. (3 marks)
(ii) State the genotypes of all individuals in generation II (3 marks)
(iii) If **IV-4** marries an affected husband, calculate the probability of having 4 children that are normal; the probability of having 2 normal and 2 affected children and the probability of having an affected child or a normal child. (9 marks)

[TOTAL MARKS = 25]

SECTION B (ATTEMPT ANY THREE QUESTIONS FROM THIS SECTION)

Question 2

In *Drosophila*, curly wings (***k***), black body (***b***), and cinnabar eyes (***c***) result from recessive alleles that are all located on chromosome 2. A homozygous wild-type fly was mated with a curly, black, and cinnabar fly, and the resulting F_1 females were test-crossed with curly, black and cinnabar males. The following F_2progeny were produced from the test-cross:

Progeny	***Number***
$k\ b^+\ c$	*117*
$k^+\ b^+\ c^+$	*825*
$k^+\ b\ c$	*50*
$k^+\ b^+\ c$	*6*
$k\ b\ c$	*828*
$k\ b^+\ c^+$	*51*
$k^+\ b\ c^+$	*115*
$k\ b\ c^+$	*8*
Total	***2000***

(a) Make a table to indicate parental, single-crossover and double crossover-progeny. (5 marks)
(b) Determine the linear order of the genes. (5 marks)
(c) Using recombinant frequencies, calculate the map distances between the genes and sketch the genetic map. (10 marks)
(d) Determine the coefficient of coincidence and the interference for these loci. (3 marks)
(e) Explain what the interference tell us about the effect of one crossover on another. (2 marks)

[TOTAL MARKS = 25]

Question 3

(a) Explain the following:
(i) principle of segregation, (3 marks)
(ii) principle of independent assortment, (3 marks)
(iii) partial dominance, (3 marks)
(iv) co-dominance, (3 marks)
(v) dominant epistasis. (3 marks)

(b)Using examples, explain why expression of some X-linked genes in female mammals result in mosaic phenotypes. (10 marks)

[TOTAL MARKS = 25]

[PLEASE TURN OVER]

Question 4

(a) In a population of some insect species, the body length shows a continuous distribution with a mean of 7 mm. Males and females together with body lengths of 10 mm are removed and interbred to give progeny of average body length 8.1 mm. Calculate the heritability in the narrow sense for body length. (10 marks)

(b) In a plant, height varies from 6 to 36 cm. When 6-cm and 36-cm plants were crossed, all plants were 21 cm. In the F_2 generation, a continuous range of heights was observed. Most were around 21 cm, and 3 of 200 were short as the 6-cm P_1 parent.

(i) State the mode of inheritance, and calculate the number of genes involved. (5 marks)

(ii) Calculate the contribution of each allele to the plant height. (5 marks)

(iii) Distinguish between a genomic library and a cDNA library. (5 marks)

[TOTAL MARKS = 25]

Question 5

(a) Explain how nuclear and organelle genomes cooperate at the protein level. (5 marks)

(b) Two species of *Epilobium* (fireweed) are intercrossed reciprocally as follows:

♀*E. luteum* × ♂*E. hirsutum* ⟶ all very tall

♀*E. hirsutum* × ♂*E. luteum* ⟶ all very short

The progeny from the first cross are backcrossed as females to *E. hirsutum* for 24 successive generations. At the end of this crossing program, all the progeny still are tall, like the initial hybrids.

(i) Interpret the reciprocal crosses. (5 marks)

(ii) Explain why the program of backcrosses was performed. (5 marks)

(c) Compare and contrast the special features of mitosis and meiosis. (10 marks)

[TOTAL MARKS = 25]

Question 6

Outline how you can get a gene of interest from genomic DNA of a hypothetical animal and clone it in order to get the protein encoded by that gene. In your outline, you should highlight the methodology of acquisitionof the gene of interest, the choice and characteristics of the expression vector, choice of host, transformation and screening processes. (25 marks)

[TOTAL MARKS = 25]

END OF QUESTION PAPER