UNIVERSITY OF SWAZILAND
FACULTY OF SCIENCE AND ENGINEERING
DEPARTMENT OF BIOLOGICAL SCIENCES

MAIN EXAMINATION PAPER 2017/2018

PROGRAMMES: BSc. II & III
B. Ed Secondary II & III

COURSE CODE: B303/BIO211

TITLE OF PAPER: GENETICS

TIME ALLOWED: TWO (3) HOURS

INSTRUCTIONS:
1. ANSWER QUESTION ONE IN SECTION A AND ANY OTHER TWO QUESTIONS IN SECTION B.

2. CANDIDATES MAY USE SCIENTIFIC CALCULATORS.

DO NOT OPEN THIS PAPER UNTIL PERMISSION HAS BEEN GRANTED BY THE CHIEF INVIGILATOR

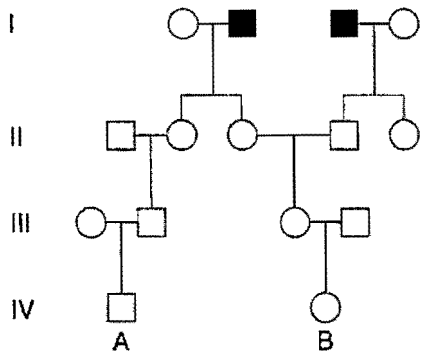
Section A
Answer ALL questions in this section

Question 1 (Compulsory)

(a) A cross between a black and a brown mouse gives all black. Selfing F_1 yields 152 black and 51 brown mice.
(i). Using letters of your own choosing, state the most likely genotypes of the parents , indicating the dominant and recessive phenotypes. (2 marks)
(ii). Based on your answer to (i), state the expected genotypes of the F_1. (2 marks)
(iii). Based on your answers to (i) and (ii), state the expected genotypes of the F_2 and the ratio in which they should occur. (2 marks)
(iv). State the phenotype of each genotype in the F_2 and use this to predict the phenotypic ratio of the F_2 generation. (2 marks)

(b) Ptosis (droopy eyelids) may be inherited as a dominant human trait. Among 240 people who are heterozygous for the ptosis allele, 39 have ptosis and 81 have normal eyelids.
(i) Calculate the penetrance for ptosis. (2 marks)
(ii) If ptosis had variable expressivity in this population, what would that mean? (2 marks)

(c) Consider the accompanying pedigree of a rare autosomal recessive disease, PKU. Assume that all people marrying into the pedigree lack the abnormal allele.



(i) If individuals A and B marry, what is the probability that their first child will have PKU? (4 marks)
(ii) If their first child is normal, what is the probability that their second child will have PKU? (1 mark)
(iii) If their first child has the disease, what is the probability that their second child will be a carrier girl? (1 mark)
(iv) If their first child has the disease and their second child is born normal, what is the probability that this second child is not a carrier? (1 mark)

(e) A pure-breed albino labrador is mated with a pure-bred black Labrador. All the F_1 are black. When the black F_1 progeny are crossed with each other, 89 black, 31 brown, and 42 albino dogs were obtained.

(i) Explain the observations described above. (4 marks)
(ii) Using letters of your own choice, indicate the genotypes of the two pure breeding parental dogs, the F_1, and the F_2 progeny. (8 marks)

(f) A *Neurospora* cross is made between a strain that carries the mating-type allele ***A*** and the wild-type ***arg***$^{+}$ and another strain that carries the mating type allele ***a*** and the mutant allele for ***arg***. Four hundred linear octads are isolated, and they fall into the seven classes given in the table below. (For simplicity, they are shown as tetrads and wild type allele is denoted by "**+**".)

	Octad class						
	1	2	3	4	5	6	7
	+ . +	+ . *arg*	+ . +	+ . +	+ . +	+ . *arg*	+ . *arg*
	+ . +	+ . *arg*	+ . *arg*	*a* . +	*a* . *arg*	*a* . +	*a* . +
	a . *arg*	*a*. +	*a* . +	+ . *arg*	+ . +	+ . *arg*	+ . +
	a . *arg*	*a* . +	*a* . *arg*	*a* . *arg*	*a* . *arg*	*a* . +	*a* . *arg*
Σ	129	125	95	34	3	7	7

Determine the linkage between the ***a*** and ***arg*** loci. Calculate the two centromere tolocus distances and the ***a-arg*** distance (if possible). (9 marks)

(g) A herd of pure breeding black polled (hornless) bulls was allowed to mate with a herd of pure breeding horned brown cows. All F1 calves were black and hornless. One F_1 bull and a fellow F_1 cow are crossed to get an F_2 calf. Explain the genetic relationships between the two fur colour phenotypes as well as polled and horned phenotypes. Hence, calculate the probability that the F_2 calf will have either horns or brown fur. (10 marks)

[Total Marks = 50]

Section B
Answer ANY TWO questions in this section

Question 2

(a) Briefly explain why the relation between genotype and phenotype is frequently complex for quantitative characteristics. (6 marks)

(b) Explain how the response to selection is related to narrow-sense heritability and selection differential. State the usefulness of the response to selection in animal and plant breeding. (6 marks)

(c) Assume that seed weight is determined by a pair of alleles at each of two independently assorting loci (***A*** and ***a***, ***B*** and ***b***) that are additive in their effects. In addition, assume that each allele represented by an uppercase letter contributes 4g to weight and each allele represented by a lowercase letter contributes 1g to weight.

(i) If a plant of genotype ***AABB*** is crossed with one of genotype ***aabb***, predict the weight of seeds that are expected in the F_1 progeny. (5 marks)

(ii) Determine classes of seed weight expected in the F_2 progeny. Indicate their expected ratios. (8 marks)

[Total marks = 25]

Question 3

(a) Mellisa is a rice breeder. She has a farm with a population of genotypically identical rice plants, where variance for grain yield is 3.51. Would it be prudent to advise her to improve yield in this strain of rice by artificial selection? Explain your answer. (2 marks)

(b) A recessive mutation in goats causes a defect in courtship behaviour. The affected individuals are perfectly viable, but never reproduce. The wild type dominant allele is ***A*** and the recessive disease allele is ***a***. In a large population study, Thando has determined that 1 in 8,000 goats are affected with this disease. Given that this population is in Hardy-Weinberg equilibrium, determine the following:

(i) The frequencies of the dominant and recessive alleles in this population. (4 marks)

(ii) The frequencies of the ***AA***, ***Aa***, and ***aa*** genotypes in the adult population. (4 marks)

(c) In *Drosophila melanogaster*, cut wings (***ct***) is recessive to normal wings (ct^+), sable body (***s***) is recessive to gray body (s^+), and vermilion eyes (***v***) is recessive to red eyes (v^+). All three recessive mutations are X-linked. A female fly with cut wings, sable body, and vermilion eyes is crossed to a male homozygous for normal wings, gray body and red eyes. The F_1 females produced by this cross are mated with cut, sable, vermilion males in a testcross. The progeny resulting from the testcross are listed below:

v	ct	s	510
v^+	ct	s	1
v^+	ct^+	s	14
v^+	ct^+	s^+	500
v^+	ct	s^+	73
v	ct	s^+	20
v	ct^+	s	81
v	ct^+	s^+	1
Total→			1200

Calculate genetic interference between the neighbouring cross-over regions.

(15 marks)

[Total marks = 25]

Question 4

(a) Discuss the different chromosomal aberrations and gene mutations. (20 marks)

(b) In sheep, lustrous fleece results from an allele that is dominant over an allele for normal fleece. A ewe (adult female) with lustrous fleece is mated with a ram (adult male) with normal fleece. The ewe then gives birth to a single lamb with normal fleece. From this single offspring, is it possible to determine the genotypes of the two parents? If so, what are their genotypes? If not, why? (5 marks)

[Total marks = 25]

END OF EXAM PAPER