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

SUPPLEMENTARY/RE-SIT EXAMINATION PAPER 2016/2017

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.

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Section A
Answer ALL questions in this section

Question 1 (Compulsory)

(a) Explain why meiosis leads to genetic variation while mitosis does not. (2 marks)

(b) Explain the difference between mitosis and 2nd division of meiosis. (2 marks)

(c) Suppose you perform a cross between a black-eyed mouse and a red-eyed mouse of unknown genotypes, and all the progeny have black eyes (F_1). You cross the F_1 progeny with one another and you get 76 black-eyed mice and 26 red-eyed mice in the F_2 generation.

(i). Using letters of your own choosing, state the most likely genotypes of the two parents (P) in cross 1, stating which phenotypes are dominant and recessive. (2 marks)

(ii). Based on your answer to part (i), state the expected genotypes of the F_1. (2 marks)

(iii). Based on your answers to parts (i) and (ii), state the expected genotypes of the F_2 and the ratio in which they should occur. (2 marks)

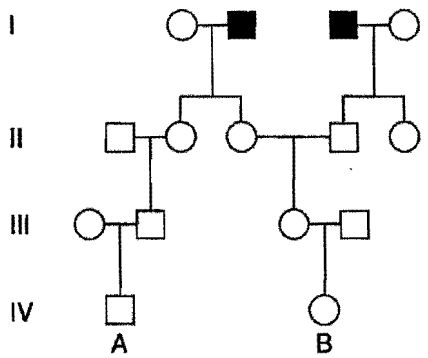
(iv). State the phenotype of each genotype in the F_2 and use this to predict the phenotypic ratios in the F_2 generation. (2 marks)

(v). State a suitable hypothesis and use a Chi Square (χ^2) test to verify whether the observed F_2 distribution is consistent with your hypothesis at 5% significance level. (4 marks)

Critical Values of the χ^2 Distribution

	Significance level (α)								
df	**.995**	**.975**	**.9**	**.5**	**.1**	**.05**	**.025**	**.01**	**.005**
1	.000	.000	0.016	0.455	2.706	3.841	5.024	6.635	7.879
2	0.010	0.051	0.211	1.386	4.605	5.991	7.378	9.210	10.597
3	0.072	0.216	0.584	2.366	6.251	7.815	9.348	11.345	12.838
4	0.207	0.484	1.064	3.357	7.779	9.488	11.143	13.277	14.860

(d) 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? (2 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 unaffected? (1 mark)

(e) You mate pure-breeding white mouse with another pure-breeding strain of brown mice, and all the F_1 are black. When the black F_1 are selfed, you obtain 89 black, 31 brown, and 42 white offspring (F_2). Suggest a likely genetic model for the inheritance of coat color in these crosses. Using letters of your own choosing, define the phenotypes of each allele. State the genotypes of the two pure breeding parental strains, the genotypes of the F_1, and the genotypes of the F_2. (8 marks)

(f) In a maternity ward, 4 babies become accidentally mixed up. The ABO types of the babies are known to be **O, A, B,** & **AB**. The ABO types of the four sets of parents are determined. Indicate, with justification, which baby belongs to each set of parents:

(i). AB x O, (2 marks)
(ii). A x O, (2 marks)
(iii). A x AB, (2 marks)
(iv). O x O. (2 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 F_1 calves were black and hornless. One F_1 bull and a fellow F_1 cow were crossed to get an F_2 calf.

(i) Explain the genetic relationships between the two fur colour phenotypes as well as polled and horned phenotypes. (4 marks)

(ii) 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) Tawanda is a rice breeder. He 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 him to improve yield in this strain of rice by artificial selection? Explain your answer. (3 marks)

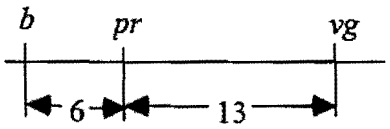
(b) A recessive mutation in goats causes a defect in courtship behaviour. The affected individuals are perfectly viable, but never reproduce. (The wild type dominant allele is ***A***, the recessive disease allele is ***a***). In a large population study, Banele determined that 1 in 8,000 goats are affected 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. (3 marks)

(ii) The frequencies of the ***AA***, ***Aa***, and ***aa*** genotypes in the adult population. (3 marks)

(iii) The mutation rate at which **A** alleles mutate into **a** alleles. (3 marks)

(c) In *Drosophila melanogaster,* black body (*b*) is recessive to gray body (b^+), purple eyes (*pr*) are recessive to red eyes (pr^+), and vestigial wings (*vg*) are recessive to normal wings (vg^+). The loci coding for these traits are linked, with the map distances:



The interference among these genes is 0.5. A fly with black body, purple eyes, and vestigial wings is crossed with a fly homozygous for gray body, red eyes, and normal wings. The female progeny are then crossed with males that have black body, purple eyes, and vestigial wings. If 1000 progeny are produced from this testcross, what will be the genotypes and proportions of the progeny? (13 marks)

[Total marks = 25]

Question 3

(a) Discuss the different chromosomal aberrations and gene mutations. (12 marks)

(b) In fruit flies, lobed eyes (***l***) are recessive to normal (l^+), curly wings (***c***) are recessive to normal wings (c^+), and sepia eyes (**e**) is recessive to red eyes (e^+). The loci coding for these traits are linked, with the map distances are: ***l-c*** = 16 m.u and ***c-e*** = 6.5 m.u. The interference among these genes is 0.7. A fly with a lobed, sepia eyes and curly wings is crossed with a fly homozygous for normal wings, normal shaped and red eyes. The female progeny are then crossed with males that have lobed, sepia eyes and curly wings. If 998 progeny are produced from this testcross, decipher the genotypes and proportions of the progeny. (13 marks)

[Total marks = 25]

Question 4

(a) Briefly explain why the relation between genotype and phenotype is frequently complex for quantitative characteristics. (2 marks)

(b) Briefly explain how QTL mapping is used to locate genes affecting a polygenic characteristic. (3 marks)

(c) 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. (5 marks)

(d) 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 weights of seeds that are expected in the F_1 progeny. (3 marks)

(ii) Determine classes of seed weights expected in the F_2 progeny. Indicate their expected proportions. (6 marks)

(e) An X-linked dominant allele causes hypophosphatemia in humans. A man with hypophosphatemia marries a normal woman.
(i) Calculate the probability that their sons will be affected. (3 marks)
(ii) Calculate the probability that a daughter and a son will be affected. (3 marks)

[Total marks = 25]

END OF EXAM PAPER