

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

SUPPLEMENTARY/RE-SIT 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.

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Section A

Answer ALL questions in this section

Question 1 (Compulsory)

- (a) Explain the chromosome theory of inheritance (6 marks)
- (b) Explain two meiotic processes that are responsible for genetic variation. (6 marks)
- (c) Assuming that genes assort independently, state the phenotypic ratios produced by the following crosses:
- (i) a selfed monohybrid, (1 mark)
 - (ii) a selfed dihybrid, (1 mark)
 - (iii) a test-crossed dihybrid. (1 mark)
- (d) Tay-Sachs disease is a rare human recessive disease. A woman is planning to marry her first cousin, but the couple discover that their shared grandfather's sister died in infancy of Tay-Sachs disease.
- (i) Draw the relevant parts of the pedigree, and show all the genotypes as completely as possible. (6 marks)
 - (ii) Calculate the probability that their first child will have the disease, assuming that all people who marry into the family are homozygous normal? (4 marks)
- (e) Lerato and Thando are considering having children, but Thando's brother has galactosemia (an autosomal recessive disease) and Lerato's great-grandmother also had galactosemia. Lerato has a sister who has three children, none of whom have galactosemia. What is the probability that Thando and Lerato will have a child with galactosemia? (5 marks)
- (f) A normal man (A) whose grandfather had a recessive genetic and a normal woman (B) whose mother had the same genetic disorder want to have a child. What is the probability that their first child will have a disorder? (5 marks)
- (g) In rabbits, coat colour is a genetically determined characteristic. Some black females always produce black progeny, whereas other black females produce black progeny and white progeny. Explain these observations. (6 marks)
- (h) Explain what is meant by dosage compensation, highlighting how this is achieved in mammals and *Drosophila*. Hence, describe one piece of evidence that suggests that the process that causes dosage compensation in female mammals occurs at random. (9 marks)

[Total Marks = 50]

Section B

Answer ANY TWO questions in this section

Question 2

- (a) Describe the molecular organisation of eukaryotic chromosomes. (4 marks)
- (b) Describe the following, explaining how they might arise:
- (i) trisomy, (2 marks)
 - (ii) monosomy, (2 marks)
 - (iii) Robertsonian translocation, (3 marks)
 - (iv) frameshift mutation, (5 marks)
 - (v) point mutations. (9 marks)

[Total Marks = 25]

Question 3

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 is mated with a curly, black, and cinnabar fly, and the resulting F₁ females are test-crossed with curly, black and cinnabar males. The following 2000 F₂ progeny and their frequencies are produced from the test-cross:

$k^+ b^+ c$	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

Use the data above to determine the order of genes on the chromosome, then compute the coefficient of coincidence and gene interference during recombination. (25 marks)

Question 4

- (a) Briefly explain why the relationship between genotype and phenotype is frequently complex for quantitative characteristics. (5 marks)
- (b) Explain how broad-sense and narrow-sense heritabilities differ. (4 marks)
- (c) Approximately 70% of all caucasians can taste the chemical phenylthiocarbamide, while the remainder cannot. The ability to taste this chemical is determined by the dominant allele *T*, and the inability to taste is determined by the recessive allele *t*. If the population is in Hardy-Weinberg equilibrium, determine the genotypic and allelic frequencies of this population. (6 marks)
- (d) In an experimental population of *Tribolium confusum* (flour beetles), body length shows a continuous distribution with a mean of 6 mm. A group of males and females with a mean body length of 9 mm are artificially selected and interbred. The body lengths of their offspring averaged 7.2 mm. Determine the narrow sense heritability in this population. (4 marks)
- (e) In a large herd of cattle, the variances for shank length were measured as indicated in the table below.

Type of Variance	Value
Phenotypic	320.2
Environmental	248.1
Additive genetic	46.5
Dominance genetic	15.6

Calculate the broad- and narrow-sense heritabilities for shank length. (6 marks)

[Total Marks = 25]

END OF EXAM PAPER