UNIVERSITY OF ESWATINI
FACULTY OF SCIENCENCE & ENGINEERING
DEPARTMENT OF BIOLOGICAL SCIENCES
MAIN EXAMINATION PAPER 2018/2019

COURSE CODE: B303/BIO211

TITLE OF PAPER: GENETICS

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:

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

2. CANDIDATES MAY USE SCIENTIFIC CALCULATORS

3. QUESTION 1 CARRIES 50 MARKS AND EACH QUESTION IN SECTION B CARRIES 25 MARKS

4. ILLUSTRATE YOUR ANSWERS WITH LARGE CLEARLY LABELLED DIAGRAMS WHERE APPROPRIATE

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Section A (Compulsory)
Answer ALL questions in this section

Question 1

(a) Explain the chromosome theory of inheritance, highlighting its relationship with meiosis and Mendel's laws. [10 marks]

(b) Explain why tortoiseshell and calico cats are almost always female, highlighting why they have a patchy distribution of orange and black fur. [10 marks]

(c) Describe the molecular organisation of eukaryotic chromosomes. [10 marks]

(d) 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 were then 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]

(e) A pure-breed albino mice is mated with a pure-bred black mice. All the F_1 are black. When the black F_1 progeny are crossed with each other, 89 black, 31 agouti, and 42 albino mice were obtained.
(i) Explain the observations described above. [2 marks]
(ii) Using letters of your own choice, indicate the genotypes of the two pure breeding parental mice, the F_1, and the F_2 progeny. [8 marks]

[Total marks = 50]

Section B (Answer any two questions from this section)

Question 2

(a) State four traditional subdivisions of genetics and briefly explain what each covers. [9 marks]

(b) Explain the difference between the following:
(i) Epistasis and dominance, [4 marks]
(ii) Pleiotropy and polygenic inheritance. [6 marks]

(c) Explain the following genetic phenomena.
(i) In the absence of epistasis, a heterozygous progeny has a different phenotype from the two homozygous parents. [3 marks]
(ii) Two heterozygous Manx cats (Mn) when crossed give progeny in the ratio of 2 Manx cats (Mn): 1 normal-tailed cat (mm) but not the expected 3: 1 monohybrid ratio. [3 marks]

[Total marks = 25]

Question 3

(a) Explain the phenomenon of non-disjunction in humans, highlighting the different aneuploidy scenarios that may arise, including few of their associated phenotypic manifestations. [15 marks]

(b) John and Martha are contemplating having children, but John's brother has galactosemia (an autosomal recessive disease) and Martha's great-grandmother also had galactosemia. Martha has a sister who has three children, none of whom have galactosemia. With the aid of a genotyped pedigree, determine the risk that John and Martha's first child will have galactosemia. [10 marks]

[Total marks = 25]

Question 4

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 F1 females were test-crossed with curly, black and cinnabar males. The genotypes and frequencies of F_2 progeny produced from the test-cross are as given below:

k b⁺ c	***117;***	***k⁺ b⁺ c⁺***	***825***
k⁺ b c	***50;***	***k⁺ b c***	***828***
k⁺ b⁺ c	***6;***	***k⁺ b c⁺***	***115***
k b⁺ c⁺	***51;***	***k b c⁺***	***8***
Total			***2000***

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

[Total marks = 25]

END OF EXAMINATION PAPER