



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF APPLIED BIOLOGY AND BIOCHEMISTRY

BACHELOR OF SCIENCE HONOURS DEGREE

THEORY: GENETICS SBB 1204

AUGUST 2009

3 HOURS (100 MARKS)

INSTRUCTIONS

Answer Four (4) Questions. Each question carries 25 marks. Where a question contains subdivisions, the mark value for each subdivision is given in brackets. Illustrate your answer where appropriate with large, clearly labelled diagrams

1. Describe the different types of chromosomal breaks and reunions that result in variations in chromosome structure.
2. Write short notes on the following:
 - (a) Epistasis, (5 marks)
 - (b) Sex influenced and sex limited traits, (5 marks)
 - (c) Aneuploidy, (5 marks)
 - (d) Heterosis. (10 marks)
- 3(a) Describe the methods used for artificial selection in crop and animal breeding. (15 marks)
- 3(b) Two homozygous varieties of *Nicotiana longiflora* were crossed to produce F_1 hybrids. The average variance of corolla length for all the three populations was 8.76. The variance of the F_2 was 40.96. Estimate the heritability of flower length in the F_2 population. (5 marks)
- 3(c) A beef cattle index (I) for selecting replacement heifers takes the form $I = 6 + 2WW' + WG'$, where WW' is weaning weight in standard form and WG' is weaning grade in standard form. The average weaning weight of the herd is 250 kg with a standard deviation of ± 15 . The average weaning grade (a numerical score) is 88.6 with a standard deviation of ± 2.1 . Determine which of the animals in the table below has the best overall merit. (5 marks)

Animal	Actual Weaning Weight	Actual Weaning Grade
A	253	88
B	240	91

4. In Tuli cattle the genotype $C^R C^R$ is phenotypically red, $C^R C^W$ is roan (a mixture of red and white) and $C^W C^W$ is white. A population of Tuli found in Gwanda district had 728 red, 924 roan and 215 white animals.

- (a) Calculate the estimated frequencies of the C^R allele and the C^W allele in the gene pool of the population. (6 marks)
- (b) If this population is completely panmictic, what zygotic frequencies will be expected in the next generation? (4 marks)
- (c) Use an appropriate statistical test to determine if this cattle population is in equilibrium. (15 marks)

5(a) A woman is heterozygous for four gene pairs and homozygous for six gene pairs.

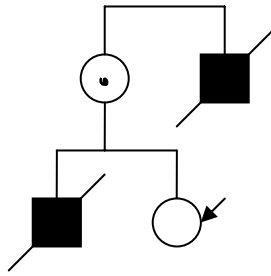
- (i) How many different kinds of gametes can she form? (3 marks)
- (ii) If her husband has the same genetic constitution as she does, how many different kinds of genotypes are possible among their offspring? (3 marks)
- (iii) If Aa were one of the gene pairs for which both of these parents were heterozygous, what is the probability that they would have two children the first Aa and the second aa? (2 marks)
- (iv) After the first two children were born what is the probability that their next child would be AA? (1 mark)

5(b) In *Drosophila*, the genes *ct* (cut wing margin), *y* (yellow body) and *v* (Vermillion eye colour) are sex linked. Females heterozygous for all three genes were mated with wild type males and the following progeny were obtained.

<i>ct</i>	<i>y</i>	<i>v</i>	4
<i>ct</i>	<i>y</i>	+	93
<i>ct</i>	+	<i>v</i>	54
<i>ct</i>	+	+	349
+	<i>y</i>	<i>v</i>	331
+	<i>y</i>	+	66
+	+	<i>v</i>	97
+	+	+	6

- (i) What genotype did the female parents have? (3 marks)
- (ii) What is the order and configuration of these genes on the chromosome? (3 marks)
- (iii) calculate the recombination frequencies between the genes. (8 marks)
- (iv) Draw a genetic map of the genes. (2 marks)

6(a) In the pedigree below, the maternal uncle (I-2) and brother (II-1) of the consultand (II-2) were affected with Duchenne muscular dystrophy (DMD) a severe X-linked recessive disease. DMD carrier women can be diagnosed using a creatine phosphokinase (CPK) test. An elevated CPK level is an indication of one being a carrier, however, this occurs in 67% of DMD carriers, furthermore, 5% of non-carrier women have an abnormal serum CPK.



The consutant (II-2) took the test and her CPK levels was within normal limits.

- (i) Using Bayesian analysis determine the probability that II-2 is a DMD Carrier, given that she tested CPK negative. (12 marks)
 - (ii) If II-2 had a son what is the probability that he will be affected by DMD? (3 marks)
- 6(b) Distinguish between penetrance and expressivity. (10 marks)

END OF EXAMINATION