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1ST SEM. 2009/2010

UNIVERSITY OF SWAZILAND

SUPPLEMENTARY EXAMINATION PAPER: JUNE 2010

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PROGRAMMES:	**(1) BSC AGRICULTURAL EDUCATION II** **(2) BSC AGRONOMY II** **(3) BSC ANIMAL SCIENCE II** **(4) BSC HORTICULTURE II**
COURSE CODE:	**AS204**
TITLE OF OF PAPER:	**PRINCIPLES OF GENETICS**
TIME ALLOWED:	**TWO (2) HOURS**
INSTRUCTIONS:	YOU <u>MUST</u> ANSWER <u>QUESTION 1</u> AND ANY OTHER 3 QUESTIONS. ALL WORKING MUST BE CLEARLY SHOWN
REQUIREMENTS:	**CANDIDATES MAY BRING CALCULATORS**

**THIS PAPER SHOULD NOT BE OPENED UNTIL PERMISSION HAS BEEN
GRANTED BY THE CHIEF INVIGILATOR**

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Question 1 (COMPULSORY)

(a) Define genotype and phenotype and explain how they are related. (3 marks)

(b) Arrange the following events in the correct temporal sequence during eukaryotic cell division, starting with the earliest: (i) condensation of the chromosomes, (ii) movement of chromosomes to the poles, (iii) duplication of the chromosomes, (iv) formation of the nuclear membrane, (v) attachment of microtubules to the kinetochores, (vi) migration of centrosomes to positions on opposite sides of the nucleus. (6 marks)

(c) Explain why meiosis leads to significant genetic variation while mitosis does not.
(4 marks)

(d) Explain what is meant by semi-conservative DNA replication. (3 marks)

(e) Differentiate frameshift mutation from point mutation. (4 marks)

(f) (i) State the mode of inheritance shown in the pedigree below. (1 marks)
(ii) Using defined symbols of your choice, give the genotypes of the individuals in I and IV generations. (2 marks)
(iii) State the type of marriage between the individuals in generation III. (1 mark)
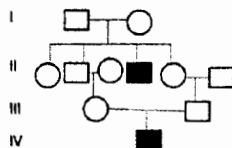
(f) In *Drosophila*, the following phenotypes are recessive: *scute* bristles (*sc*), *sable* body (*s*), and *vermillion* eyes (*v*). Nondumiso made a cross between two *Drosophila* and the following progeny were produced. The wild type genotypes or phenotypes are shown as plusses (+).

Phenotype or Genotype	Offspring population	Description of progeny
sc v *s*	314	
sc + *s*	5	
+ v *s*	157	
+ + *s*	35	
sc v +	46	
sc + +	156	
+ + +	284	
+ v +	3	
TOTAL	1000	

(i) Determine the order of genes, rearrange the genes as per their order and complete the table above. (7 marks)
(ii) Determine the map distance and draw the genetic map for these genes.
(5 marks)
(iii) Calculate the coefficient of coincidence and interference. (4 marks)

[Total 40 marks]

Question 2

(a) A woman has a rare abnormality of the eyelids called ptosis, which prevents her from opening her eyes completely. This condition is caused by a dominant allele, P. The woman's father had ptosis, but her mother had normal eyelids. Her father's mother had normal eyelids.
(i) State the genotypes of the woman, her father, and her mother.   (3 marks)
(ii) Determine the proportion of the woman's children that will have ptosis if she marries a man with normal eyelids.   (2 marks)

(b) Explain why polygenic characteristics have many phenotypes.   (5 marks)

(c) Two inbred lines of beans are intercrossed. In the F_1, the variance in bean weight is measured at 1.5. The F_1 is selfed and in the F_2, the variance in bean weight is 6.1. Estimate the broad-sense heritability of bean weight in the F_2 population.   (5 marks)

(d) In a population of mice, there are two alleles at the A locus (**A** and **a**). Tests have shown that in this population there are 384 mice of genotype **AA**, 210 of **Aa**, and 260 of **aa**. Determine the frequencies of the two alleles in the population.   (5 marks)
[Total 20 marks]

Question 3

(a) A snap dragon plant that bred true for white petals was crossed to a plant that bred true for solid purple petals, and all the F_1 had white petals. The F_1 was selfed. Among the F_2, three phenotypes were observed in the following numbers: 119 white, 31 solid purple and 10 spotted purple.

(i) Explain these observations.   (4 marks)
(ii) Using defined symbols of your choice, state the parental, F_1 and F_2 genotypes.   (8 marks)
(iii) Two F_2 plants were crossed to get F_3 in the following distribution. 50% white, 25% solid purple and 25% spotted purple. Investigate the genotypes of the two F_2 plants that were crossed.   (8 marks)
[Total 20 marks]

Question 4

(a) Tay-Sachs disease is an autosomal recessive disorder. Among Swazis, the frequency of Tay-Sachs disease is 1 in 3600. If the Swazi population is mating randomly for the Tay-Sachs gene, calculate the proportion of the population that consists of heterozygous carriers for the Tay-Sachs allele.   (5 marks)

(b) In the laboratory, Makhosazana crossed long-winged *Drosophila* flies with mutant dumpy-winged flies. In F_1, all flies had long wings. Selfing F_1 produced F_2, with the following distribution: 792 long-winged flies and 208 dumpy-winged flies. The student tested the hypothesis that the dumpy wing is inherited as a recessive trait by performing a χ^2 analysis of the F_2 data.
(i) State the genetic ratio which Makhosazana hypothesized.   (2 marks)

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(ii) Perform the χ^2 analysis and decide whether the data are consistent with the ratio above. (**Use the statistical table on page 4**)   (8 marks)

(iii) Explain what the data suggest about the dumpy mutation.   (5 marks)

[Total 20 marks]

Question 5

(a) State any three differences between meiosis and mitosis.   (3 marks)

(b) Explain the effect on DNA replication of mutations that destroy each of the following activities in DNA polymerase I:

(i) 3' → 5' exonuclease activity,   (2 marks)

(ii) 5' → 3' exonuclease activity,   (2 marks)

(iii) 5' → 3' polymerase activity.   (2 marks)

(c) The following sequence of nucleotides is found in a single-stranded DNA template: A T T G C C A G A T C A T C C C A A T A G A T

Assume that RNA polymerase proceeds along this template from left to right.

(i) Show the 5' and 3' ends of the template. Explain your answer.   (3 marks)

(ii) Give the RNA sequence and label its 5' and 3' ends.   (2 marks)

(d) (i) If a double-stranded DNA molecule has 15% thymine, calculate the percentages of all the other bases.   (3 marks)

(ii) Explain what you understand by the '*Central Dogma*' of molecular biology.   (3 marks)

[Total 20 marks]

Chi-Square Distribution Table for use in Question 4

Degrees of Freedom (df)

Probability values (p)

	0.95	0.90	0.80	0.70	0.50	0.30	0.20	0.10	0.05	0.01	0.001
1	0.004	0.02	0.06	0.15	0.46	1.07	1.64	2.71	3.84	6.64	10.83
2	0.10	0.21	0.45	0.71	1.39	2.41	3.22	4.60	5.99	9.21	13.82
3	0.35	0.58	1.01	1.42	2.37	3.66	4.64	6.25	7.82	11.34	16.27
4	0.71	1.06	1.65	2.20	3.36	4.88	5.99	7.78	9.49	13.28	18.47
5	1.14	1.61	2.34	3.00	4.35	6.06	7.29	9.24	11.07	15.09	20.52
6	1.63	2.20	3.07	3.83	5.35	7.23	8.56	10.64	12.59	16.81	22.46
7	2.17	2.83	3.82	4.67	6.35	8.38	9.80	12.02	14.07	18.48	24.32
8	2.73	3.49	4.59	5.53	7.34	9.52	11.03	13.36	15.51	20.09	26.12
9	3.32	4.17	5.38	6.39	8.34	10.66	12.24	14.68	16.92	21.67	27.88
10	3.94	4.86	6.18	7.27	9.34	11.78	13.44	15.99	18.31	23.21	29.59

END OF EXAM PAPER