UNIVERSITY OF SWAZILAND

MAIN EXAMINATION PAPER: DECEMBER 2015

TITLE OF PAPER: GENETICS

COURSE CODE: B303

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:
1. THIS PAPER IS DIVIDED INTO TWO SECTIONS
2. ANSWER QUESTION 1 (COMPULSORY) IN SECTION A AND ANY THREE OTHER QUESTIONS IN SECTION B
3. EACH QUESTION CARRIES TWENTY FIVE (25) MARKS
4. ILLUSTRATE YOUR ANSWER WITH LARGE AND CLEARLY LABELLED DIAGRAMS WHERE APPROPRIATE

SPECIAL REQUIREMENTS: CANDIDATES MAY BRING CALCULATORS

THIS PAPER SHOULD NOT BE OPENED UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATORS

SECTION A (COMPULSORY)
Question 1

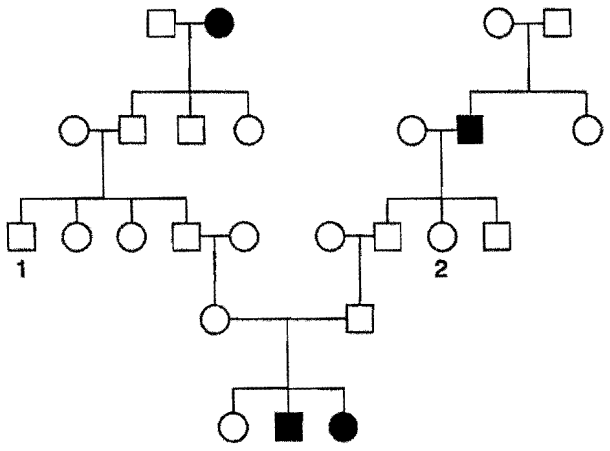
(a) Explain the relation between terms: allele, locus, gene, and genotype. (4 marks)

(b) Jabulani has XXY chromosomes (Klinefelter Syndrome) and is colour-blind. His mother and father have normal color vision, but his maternal grandfather is colour-blind. Assume that Jabulani's chromosome abnormality arose from a mistake in meiosis. In which parent and in which meiotic division did this mistake occur? Explain your answer. (4 marks)

(c) If red flower color is dominant to white flower color in Petunia, explain how one can determine whether a red-flowered Pertunia plant is homozygous dominant or heterozygous. Hence predict the likely phenotypic segregation patterns in each case. (3 marks)

(d) Suppose that a single gene controls color in some fruit. Yellow fruit colour (***Y-***) is dominant to red fruit colour (***yy***). A true breeding yellow-fruit plant was crossed with a red-fruited plant and the resulting F_1 was selfed. The F_2 segregated as expected.
(i) What is meant by the term true breeding? (1 marks)
(ii) What was the expected phenotypic segregation pattern in F_2? (1 mark)
(iii) State the genotypic ratio of the F_2 progeny. (2 marks)

(e) The following pedigree was obtained for a rare kidney disease.
(i) Deduce the likely inheritance of this condition, stating your reasons. Genotype all the individuals in this pedigree. (6 marks)
(ii) If individuals 1 and 2 marry, what is the probability that their first child will have the kidney disease? (4 marks)



[Total marks = 25]

SECTION B (ANSWER ANY THREE QUESTIONS FROM THIS SECTION)

Question 2

(a) Red-green color blindness is a human X-linked recessive disorder. Nosipho has normal color vision, but her father is color blind. Nosipho marries Majaha, who also has normal color vision. Nosipho and Majaha have a daughter who has Turner syndrome *(45,XO)* and is color blind. Explain how the daughter inherited color blindness, highlighting how her 45,XO condition came into being. (8 marks)

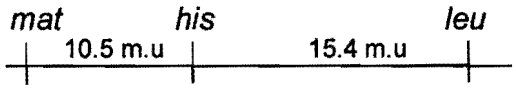
(b) When true-breeding brown dogs are mated with certain true-breeding white dogs, all the F1 puppies are white. The F_2 progeny from some $F_1 \times F_1$ crosses were 118 white, 32 black, and 10 brown puppies. Explain the genetic basis for these results. (8 marks)

(c) Briefly expound the factors that can perturb the Hardy-Weinberg equilibrium of populations of species. (9 marks)

[Total marks = 25]

Question 3

From the map below, predict the type, genotypes and number of tetrads from the cross: ***MAT-a leu*** x ***MAT-α his***. Assume you recover 900 tetrads. (25 marks)



[Total marks = 25]

Question 4

(a) In some fish species, *Poecilia latipinna*, gold color is due to a recessive allele. A gold *P. latipinna* is crossed with a normal fish. Among the offspring, 215 are normal and 213 are gold.
(i) Investigate the most likely genotypes of the parents in this cross. (5 marks)
(ii) Propose a suitable hypothesis and assess the plausibility of your hypothesis by performing a chi-square test. (12 marks)

(b) Yellow leaves on a plant can be caused by genetic mutations, viruses, or unfavorable environmental conditions. Suppose you find a plant that has yellow leaves and want to determine if the cause of the phenotype is a genetic mutation or an environmental stress. Design an experiment to differentiate between the different possibilities. (8 marks)

[Total marks = 25]

Question 5

(a) Explain the difference between the following terms.

(i) Intercalating agent and alkylating agent, (2 marks)
(ii) Point mutation and frameshift mutation, (2 marks)
(iii) Nullisomy and trisomy, (2 marks)
(iv) Base excision repair and Nucleotide excision repair, (2 marks)
(v) Familial Down Syndrome and trisomy 21 Down Syndrome. (2 marks)

(b) Discuss the likely effects of the defects in various DNA repair systems.(15 marks)

[Total marks = 25]

Question 6

Snake venoms contain more than 20 different compounds, mostly proteolytic polypeptides (cytotoxins, hemotoxins and neurotoxins). Conventionally, antivenom is created by milking venom from the desired snake; the venom is then diluted and injected into a horse, sheep, rabbit, or goat. The subject animal will undergo an immune response to the venom, producing antibodies against the venom's active molecule which can then be harvested from the animal's blood and used to treat envenomation. Suppose a particular sneaky and venomous snake has left its skin after hibernation, Devise a set of molecular biology methods you will use to produce antivenom using the snake skin as a starting material. (25 marks)

[Total marks = 25]

END OF QUESTION PAPER

Appendix: Chi-Square Distribution Table

Degrees of Freedom (*df*)	Probability (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
	Nonsignificant								Significant		