UNIVERSITY OF SWAZILAND

MAIN EXAMINATION PAPER 2007

TITLE OF PAPER: GENETICS

COURSE CODE: B303

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:

1. ANSWER ANY FOUR QUESTIONS
2. EACH QUESTION CARRIES TWENTY FIVE (25) MARKS
3. ILLUSTRATE YOUR ANSWERS WITH LARGE AND CLEARLY LABELLED DIAGRAMS WHERE APPROPRIATE
4. ALL WORKING MUST BE CLEARLY SHOWN

SPECIAL REQUIREMENTS:

a) CALCULATORS (CANDIDATES MAY BRING THEM)
b) STATISTICAL TABLES (SEE ATTACHMENT BACK PAGE)

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

QUESTION 1

a) You are approached by Mr. and Mrs. Jones (ages 30 and 23) who are concerned about the risk of their 3 month old baby developing a kidney disease that appears to run in their family. Mr Jones' mother died of renal failure at age 48. One of her two brothers died at age 35 due to the same problem. Her other brother and two sisters are alive and healthy. Mr James' maternal grandfather died at age 40, also due to kidney failure whilst his maternal grandmother lived to the age of 76 and her autopsy did not show kidney malfunction. Mr Jones also has a sister who is in good health and has two healthy sons. Mrs Jones' parents are alive and in good health and she also has a sister who is who is in good health and has a 3 year old son.

i. Draw a pedigree to summarize this information. **[8 Marks]**
ii. What is the most likely mode of inheritance for this trait? Explain the reasons for your answer. **[3 Marks]**
iii. What is the likelihood of Mr Jones developing the condition? **[2 Marks]**

b) Some dogs bark when trailing, others are silent. The barking trait is due to a dominant allele. Erect ears are dominant to drooping ears. A breeder crosses a pure-breeding barking bitch with drooping ears to a pure breeding silent male to produce an F_1.

i. Using clearly stated symbols of your choice, state the genotypes of the bitch and the male. **[2 Marks]**
ii. Show what phenotypes, and in what proportions can be expected in the F_1 and F_2 generations of this cross. **[6 Marks]**
iii. An individual who is triple heterozygous for the two genes as well as a further gene for black coat color is test crossed to an individual who is triple homozygous recessive for silent trailing, drooping ears and brown coat. Using clearly stated symbols of your choice, show what phenotypes and in what proportions can be expected among the progeny of this cross. **[4 Marks]**

[TOTAL 25 Marks]

QUESTION 2

a) A pure-breeding strain of squash that produced disk-shaped fruits was crossed with a pure-breeding strain having long fruits. The F_1 had disk-shaped fruits but the F_2 showed a new phenotype with sphere fruits in the following numbers:

Fruit shape	No. individuals
Disk	350
Sphere	267
Long	49

i. Propose an explanation for the inheritance of fruit shape in these plants. **[2 Marks]**
ii. Test how well the results fit your hypothesis. **[4 Marks]**
iii. Using clearly stated symbols of your choice, state the genotypes of all individuals in this cross. **[8 Marks]**

b) Explain what mode of inheritance is shown by the following characters, including an account of expected F_2 phenotypic ratios where appropriate:

i. Fruit shape in Shepherd's purse
ii. Manx phenotype in cats
iii. Coat colour in mammals
iv. Production of Malvidin in *Primula* **[11 Marks]**

[TOTAL 25 MARKS]

QUESTION 3

A female who is heterozygous for three genes A,B,and C is test-crossed to a triple homozygous recessive male. The following phenotypes are observed among the progeny of this cross:

Phenotype	No. individuals
ABC	390
aBc	30
aBC	85
abc	374
ABc	5
Abc	81
AbC	27
abC	8
TOTAL	**1000**

i. State the genotype of the female parent in this cross. **[2 Marks]**

ii. What other information can you deduce from the results of this cross? **[4 Marks]**
iii. Calculate recombination frequencies between all pairs of genes. **[6 Marks]**
iv. Construct a map for this region of the chromosome. **[3 Marks]**
v. How much interference, if any, is there in this region of the chromosome? **[3 Marks]**
vi. Explain fully, the difficulties involved in studying linkage in human beings. **[7 Marks]**

[25 Marks]

QUESTION 4

a) Explain what is meant by cytoplasmic inheritance. **[2 Marks]**
b) Explain why cytoplasmic genes show uniparental inheritance. **[3 Marks]**
c) How might you be able to determine if a character is under the control of cytoplasmic genes? **[3 Marks]**
d) Discuss evidence in support of the endosymbiont theory of origin of organelle DNAs. **[6 Marks]**
e) Discuss fully, the application of organelle DNA analysis in population genetic studies. Your account should include details of techniques that have been used in such studies. **[15 Marks]**

[TOTAL 25 MARKS]

QUESTION 5

A population geneticist working on a small island finds the following phenotypic distribution among 600 individuals:

A	B	AB	O
170	130	250	50

i. Calculate the allelic frequencies of all alleles involved in the control of this trait. **[8 Marks]**
ii. Use a suitable statistical test to determine if this population is at Hardy-Weinberg equilibrium. **[6 Marks]**
iii. Use Bernstein's coefficients to correct the calculated allelic frequencies.**[6 Marks]**
iv. List all the factors that can cause departure from Hardy-Weinberg equilibrium. **[5 Marks]**

[TOTAL 25 MARKS]

QUESTION 6

a) Explain the mechanism of sex determination in each of the following organisms:

i. Snakes
ii. Honey bees
iii. Grass hoppers
iv. Human beings **[10 Marks]**

b) Distinguish between the following pairs of terms:

i. Heterogametic and homogametic
ii. Heteromorphic and homomorphic
iii. Sex-linked and sex-limited traits **[6 Marks]**

c) A homozygous wildtype female fruit fly (*Drosophila melanogaster)* is crossed with a homozygous male fly with white eyes (w) and hairy body (h). The w gene is located on the X chromosome and the h gene is on chromosome 3. Note that in *Drosophila* genetic nomenclature, a "+" is used to denote the wildtype allele.

Using clearly stated symbols, show what phenotypes can be expected in the F_1 and F_2 of this cross. Your answer should include genotypes and expected frequencies. **[9 Marks]**

[TOTAL 25 MARKS]

df\area	.995	.990	.975	.950	.900	.750	.500	.250	.100	.050	.025	.010	.005
1	0.00004	0.00016	0.00098	0.00393	0.01579	0.10153	0.45494	1.32330	2.70554	3.84146	5.02389	6.63490	7.87944
2	0.01003	0.02010	0.05064	0.10259	0.21072	0.57536	1.38629	2.77259	4.60517	5.99146	7.37776	9.21034	10.59663
3	0.07172	0.11483	0.21580	0.35185	0.58437	1.21253	2.36597	4.10834	6.25139	7.81473	9.34840	11.34487	12.83816
4	0.20699	0.29711	0.48442	0.71072	1.06362	1.92256	3.35669	5.38527	7.77944	9.48773	11.14329	13.27670	14.86026
5	0.41174	0.55430	0.83121	1.14548	1.61031	2.67460	4.35146	6.62568	9.23636	11.07050	12.83250	15.08627	16.74960
6	0.67573	0.87209	1.23734	1.63538	2.20413	3.45460	5.34812	7.84080	10.64464	12.59159	14.44938	16.81189	18.54758
7	0.98926	1.23904	1.68987	2.16735	2.83311	4.25485	6.34581	9.03715	12.01704	14.06714	16.01276	18.47531	20.27774
8	1.34441	1.64650	2.17973	2.73264	3.48954	5.07064	7.34412	10.21885	13.36157	15.50731	17.53455	20.09024	21.95495
9	1.73493	2.08790	2.70039	3.32511	4.16816	5.89883	8.34283	11.38875	14.68366	16.91898	19.02277	21.66599	23.58935
10	2.15586	2.55821	3.24697	3.94030	4.86518	6.73720	9.34182	12.54886	15.98718	18.30704	20.48318	23.20925	25.18818
11	2.60322	3.05348	3.81575	4.57481	5.57778	7.58414	10.34100	13.70069	17.27501	19.67514	21.92005	24.72497	26.75685
12	3.07382	3.57057	4.40379	5.22603	6.30380	8.43842	11.34032	14.84540	18.54935	21.02607	23.33666	26.21697	28.29952
13	3.56503	4.10692	5.00875	5.89186	7.04150	9.29907	12.33976	15.98391	19.81193	22.36203	24.73560	27.68825	29.81947
14	4.07467	4.66043	5.62873	6.57063	7.78953	10.16531	13.33927	17.11693	21.06414	23.68479	26.11895	29.14124	31.31935
15	4.60092	5.22935	6.26214	7.26094	8.54676	11.03654	14.33886	18.24509	22.30713	24.99579	27.48839	30.57791	32.80132
16	5.14221	5.81221	6.90766	7.96165	9.31224	11.91222	15.33850	19.36886	23.54183	26.29623	28.84535	31.99993	34.26719
17	5.69722	6.40776	7.56419	8.67176	10.08519	12.79193	16.33818	20.48868	24.76904	27.58711	30.19101	33.40866	35.71847
18	6.26480	7.01491	8.23075	9.39046	10.86494	13.67529	17.33790	21.60489	25.98942	28.86930	31.52638	34.80531	37.15645
19	6.84397	7.63273	8.90652	10.11701	11.65091	14.56200	18.33765	22.71781	27.20357	30.14353	32.85233	36.19087	38.58226
20	7.43384	8.26040	9.59078	10.85081	12.44261	15.45177	19.33743	23.82769	28.41198	31.41043	34.16961	37.56623	39.99685