UNIVERSITY OF SWAZILAND

MAIN EXAMINATION PAPER 2006

TITLE OF PAPER: GENETICS

COURSE CODE: B303

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:

1. ANSWER 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
b) STATISTICAL TABLES (BACK PAGE)

THIS PAPER IS NOT TO BE OPENED UNTIL PERMISSION HAS

BEEN GRANTED BY THE INVIGILATORS

QUESTION 1

a. In *Drosophila melanogaster*, vestigial wings (vg) is recessive to normal wings (vg+) and the gene for this trait is located on the X chromosome. Yellow body (y) is recessive to normal body colour (y+) and this gene is located on the X chromosome. A double homozygous yellow, vestigial female is crossed to a homozygous normal male for both characters.

    i. What name is used to describe genes located on the X chromosome? **[2 Marks]**

    ii. Using **clearly stated** symbols of your choice, state the genotype of the two flies in this cross. **[2 Marks]**

    iii. Predict the genotype and phenotypes of the F_1 that would be obtained. **[2 Marks]**

    iv. What genotypes, and in what proportions can be expected in the F_2 of this cross? **[4 Marks]**

    v. If the reciprocal cross is carried out, what phenotypes, and in what proportions can be expected in the F_1 and F_2? **[6 Marks]**

b. Two people with normal children have three children as follows:

The first born is a daughter with normal vision who in turn has three sons, two of whom are colour blind.
The second is a daughter of normal vision who has five sons, all with normal vision.
The third is a colour blind son who has two daughters and two sons, all with normal vision.

    i. Summarize this information in a pedigree. **[5 Marks]**

    ii. Predict as far as possible, the genotypes of all individuals on the pedigree. **[4 Marks]**

[TOTAL 25 MARKS]

QUESTION 2

a) The chromosome •ABCDEF undergoes an interstitial break resulting in an inversion involving the regions BCDE (thus becoming •AEDCBF) where • denotes the position of the centromere.

i. Explain fully, the consequences of this during pairing in an individual who is heterozygous for this inversion using **large, fully labeled diagrams** to illustrate your answer.   **[6 Marks]**
ii. If a chiasma is formed between B and C, show the configuration of the bivalent at Anaphase 1 and show what products will arise at the end of Meiosis II.   **[6 Marks]**

b) Distinguish between the following pairs of chromosomal aberrations:

i. A paracentric and a pericentric inversion
ii. A tandem and a reverse duplication
iii. A terminal and an interstitial deletion

[6 Marks]

c) Explain how we can distinguish between different chromosomes using the position of the centromere using large diagrams to illustrate your answer.
[7 Marks]

[TOTAL 25 MARKS]

QUESTION 3

a) A snapdragon plant that bred true for white petals was crossed to a plant that bred true for purple flowers and all the F_1 had white petals. Selfing the F_1 produced an F_2 with a total of 640 individuals as follows:

White	464
Solid purple	126
Spotted purple	50

i. Suggest an explanation for the inheritance of this trait.   **[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 the parents, F_1 and all F_2 phenotypes in this cross.   **[8 Marls]**

b) Distinguish between penetrance and expressivity.   **[2 Marks]**

c) Briefly explain how the following types of genetic interaction arise including an account of what phenotypic ratios can be expected in the F_2 of crosses showing these interactions.

    i.   Gene suppression
   ii.   Complementarity
  iii.   Duplicate genes   **[9 Marks]**

[TOTAL 25 MARKS]

QUESTION 4

a) Explain the link between proteins and DNA using large, clearly labeled diagrams to illustrate your answer.   **[8 Marks]**

b) Name and explain the role of all substances and enzymes required for DNA replication   **[10 Marks]**

c) Explain how pre-mRNA is processed to resulting in a final mRNA transcript.   **[7 Marks]**

[TOTAL 25 MARKS]

QUESTION 5

A female who is heterozygous for four genes A,B,C and D is test-crossed to a aabbccdd male and 1000 progeny, classified as follows are obtained.

Phenotype	No. individuals
aBCD	42
Abcd	43
ABCd	140
abcD	145
AbCd	6
aBcD	9
ABcd	305
abCD	310

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

b. Use the information given to calculate recombination frequencies between the genes that are linked (HINT: Not all genes are linked). **[8 Marks]**

c. Construct a map for this region of the chromosome. **[3 Marks]**

d. Determine how much interference, if any, occurs in this region of the chromosome. **[3 Marks]**

e. Distinguish between the following pairs of terms:
    i.   inter-chromosomal and intra-chromosomal recombination. **[4 Marks]**
   ii.   Coupling phase and repulsion phase.   **[5 Marks]**

QUESTION 6

a) Explain what is meant by quantitative inheritance.   [2 Marks]

b) Compare and contrast between quantitative and qualitative inheritance. [7 Marks]

c) A geneticist studying a certain quantitative trait in a group of plants measures the following components among six generations of plants.

Generation	Mean	Variance
P_1	60	45
P_2	50	55
F_1	58	53
F_2	?	150
BC_1	?	120
BC_2	?	110

    i.   Calculate the components m, [d] and [h].   [6 Marks]

    ii.   Use these to predict the F_2, BC_1 and BC_2 means.   [6 Marks]

    iii. Calculate the narrow and broad sense heritability for this trait.   [4 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