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UNIVERSITY OF SWAZILAND

MAIN EXAMINATION PAPER: MAY 2017

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

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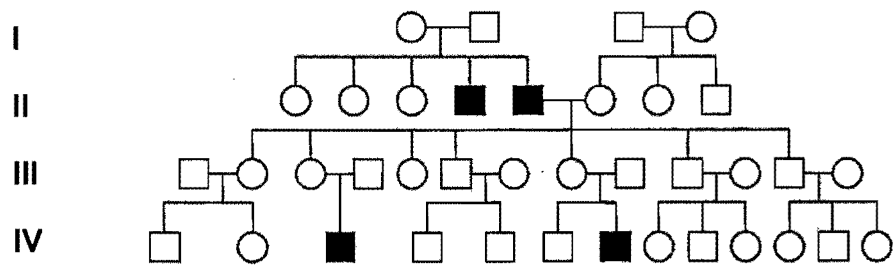
SECTION A (COMPULSORY)
Question 1

(a) Explain the chromosome theory of inheritance, indicating how it is related to Mendel's findings. (5 marks)

(b) During meiosis, when do *chromosome* disjunction and *chromatid* disjunction occur? (4 marks)

(c) 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) What are the genotypes of the woman, her father, and her mother? (3 marks)
(ii) What proportion of the woman's children will have ptosis if she marries a man with normal eyelids? (3 marks)

(d) A family with a rare disorder presents the following pedigree.



(i) State, with justifications the most likely mode of inheritance. (6 marks)

(ii) Identify all individuals that must be heterozygous. (4 marks)

[Total marks = 25]

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SECTION B (ANSWER ANY THREE QUESTIONS FROM THIS SECTION)

Question 2

(a) Discuss the common misapplications of the concept of heritability. (25 marks)

[Total marks = 25]

Question 3

The recessive alleles ***k*** (kidney-shaped eyes instead of wild-type round), **c** (cardinal-colored eyes instead of wild-type red), and **e** (ebony body instead of wild-type gray) identify three genes on chromosome 3 of *Drosophila*. Females with kidney-shaped, cardinal-colored eyes were mated with ebony males. The F_1 was wild type. When F_1 females were testcrossed with ***kk cc ee*** males, the following progeny phenotypes were obtained:

k	*c*	*e*	3
k	*c*	+	876
k	+	*e*	67
k	+	+	49
+	*c*	*e*	44
+	*c*	+	58
+	+	*e*	899
+	+	+	4
Total			2000

(a) Determine the order of the genes. Hence, draw the chromosomes of the parents and the F1 and the map distances between the genes. (18 marks)

(b) Calculate the interference and explain its significance. (7 marks)

[Total marks = 25]

Question 4

(a) Briefly explain why and how Southern blotting is carried out. (3 marks)

(b) Explain how plasmids are transferred into host cells in a research lab. (3 marks)

(c) Discuss some of the considerations that must go into developing an appropriate cloning strategy. (9 marks)

(d) Briefly explain how the polymerase chain reaction is used to amplify a specific DNA sequence, highlighting the limitations of PCR. (10 marks)

[Total marks = 25]

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Question 5

In one experiment, pure breeding black Labrador male dog was crossed with a pure breeding brown Labrador bitch. The resulting F_1 puppies were all black. Selfing F_1 resulted in a black: brown puppy distribution of 3:1. In another experiment, a man allowed his pure breeding black Labrador bitch to mate with a friend's pure breeding albino male dog resulting in all black puppies in the F_1 generation. The F_1 progeny were allowed to self to give 48 F_2 puppies comprising 26 black, 10 brown and 12 albino phenotypes.

(a) Explain these results in genetic terms. (4 marks)

(b) Using defined symbols of your choice, determine the genotypes of Parents, F_1 progeny and F_2 progeny in the second experiment. (15 marks)

(c) One F_2 albino female dog was crossed with an F_2 black male. The resulting F_3 progeny had the following distribution: 50% albino: 37.5% Black: 12.5% brown. Investigate the genotypes of the F_2 progeny used in the cross and give the genotypes of all the F_3 progeny. (6 marks)

[Total marks = 25]

Question 6

(a) In rabbits, the dominant allele *B* causes black fur and the recessive allele *b* causes brown fur; for an independently assorting gene, the dominant allele ***R*** causes long fur and the recessive allele ***r*** causes short fur. A homozygous rabbit with long, black fur is crossed with a rabbit with short, brown fur, and the offspring are intercrossed. In the F_2, what proportion of the rabbits with long, black fur will be homozygous for both genes? (12 marks)

(b) Mendel testcrossed pea plants grown from yellow, round F_1 seeds to plants grown from green, wrinkled seeds and obtained the following results: 30 yellow, round; 25 green, round; 28 yellow, wrinkled; and 27 green, wrinkled. Are these results consistent with the hypothesis that seed color and seed texture are controlled by independently assorting genes, each segregating two alleles? (13 marks)

[Total = 25 marks]

END OF QUESTION PAPER

FOR B303 EXAM

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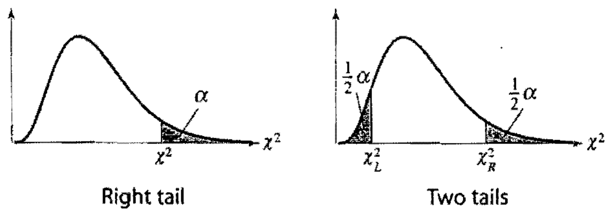
Table 6 — Chi-Square Distribution



Degrees of freedom	α									
	0.995	0.99	0.975	0.95	0.90	0.10	0.05	0.025	0.01	0.005
1	—	—	0.001	0.004	0.016	2.706	3.841	5.024	6.635	7.879
2	0.010	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210	10.597
3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12.838
4	0.207	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277	14.860
5	0.412	0.554	0.831	1.145	1.610	9.236	11.071	12.833	15.086	16.750
6	0.676	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812	18.548
7	0.989	1.239	1.690	2.167	2.833	12.017	14.067	16.013	18.475	20.278
8	1.344	1.646	2.180	2.733	3.490	13.362	15.507	17.535	[illegible]	21.955
9	1.735	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666	23.589
10	2.156	2.558	3.247	3.940	4.865	15.987	18.307	20.483	23.209	25.188
11	2.603	3.053	3.816	4.575	5.578	17.275	19.675	21.920	24.725	26.757
12	3.074	3.571	4.404	5.226	6.304	18.549	21.026	23.337	26.217	28.299
13	3.565	4.107	5.009	5.892	7.042	19.812	22.362	24.736	27.688	29.819
14	4.075	4.660	5.629	6.571	7.790	21.064	23.685	26.119	29.141	31.319
15	4.601	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.578	32.801
16	5.142	5.812	6.908	7.962	9.312	23.542	26.296	28.845	32.000	34.267
17	5.697	6.408	7.564	8.672	10.085	24.769	27.587	30.191	33.409	35.718
18	6.265	7.015	8.231	9.390	10.865	25.989	28.869	31.526	34.805	37.156
19	6.844	7.633	8.907	10.117	11.651	27.204	30.144	32.852	36.191	38.582
20	7.434	8.260	9.591	10.851	12.443	28.412	31.410	34.170	37.566	39.997
21	8.034	8.897	10.283	11.591	13.240	29.615	32.671	35.479	38.932	41.401
22	8.643	9.542	10.982	12.338	14.042	30.813	33.924	36.781	40.289	42.796
23	9.260	10.196	11.689	13.091	14.848	32.007	35.172	38.076	41.638	44.181
24	9.886	10.856	12.401	13.848	15.659	33.196	36.415	39.364	42.980	45.559
25	10.520	11.524	13.120	14.611	16.473	34.382	37.652	40.646	44.314	46.928
26	11.160	12.198	13.844	15.379	17.292	35.563	38.885	41.923	45.642	48.290
27	11.808	12.879	14.573	16.151	18.114	36.741	40.113	43.194	46.963	49.645
28	12.461	13.565	15.308	16.928	18.939	37.916	41.337	44.461	48.278	50.993
29	13.121	14.257	16.047	17.708	19.768	39.087	42.557	45.722	49.588	52.336
30	13.787	14.954	16.791	18.493	20.599	40.256	43.773	46.979	50.892	53.672
40	20.707	22.164	24.433	26.509	29.051	51.805	55.758	59.342	[illegible]	[illegible]
50	27.991	29.707	32.357	34.764	37.689	63.167	67.505	71.420	76.154	[illegible]
60	35.534	37.485	40.482	43.188	46.459	74.397	79.082	83.298	[illegible]	[illegible]
70	43.275	45.442	48.758	51.739	55.329	85.527	90.531	95.023	[illegible]	[illegible]
80	51.172	53.540	57.153	60.391	64.278	96.578	101.879	106.629	[illegible]	[illegible]
90	59.196	61.754	65.647	69.126	73.291	107.565	113.145	118.136	124.116	[illegible]
100	67.328	70.065	74.222	77.929	82.358	118.498	124.342	129.561	[illegible]	[illegible]

05/04/2017

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