COURSE CODE: B303(M) 2016/2017

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# **UNIVERSITY OF SWAZILAND**

68

**MAIN EXAMINATION PAPER: MAY 2017** 

TITLE OF PAPER:

**GENETICS** 

**COURSE CODE:** 

**B303** 

1.

TIME ALLOWED:

**THREE HOURS** 

INSTRUCTIONS:

THIS PAPER IS DIVIDED INTO TWO SECTIONS

2. ANSWER QUESTION 1 (COMPULSORY) IN SECTION A AND ANY THREE OTHER QUESTIONS IN SECTION B

**EACH QUESTION CARRIES TWENTY FIVE (25) MARKS** 3.

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** 

69

# SECTION A (COMPULSORY)

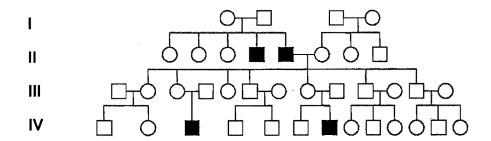
Question 1

- (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]

# SECTION B (ANSWER ANY THREE QUESTIONS FROM THIS SECTION)

70

#### 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	С	е	3		
k	С	+ ,	876		
k	+	е	67		
k	+	+	49		
+	С	е	44		
+	С	58			
+	+	899			
+	+	+	4		
	Total				

- (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)

(3 marks)

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

(a)

In one experiment, pure breeding black Labrador male dog was crossed with a pure breeding brown Labrador bitch. The resulting F<sub>1</sub> puppies were all black. Selfing F<sub>1</sub> 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<sub>1</sub>

generation. The F<sub>1</sub> progeny were allowed to self to give 48 F<sub>2</sub> puppies comprising 26 black, 10 brown and 12 albino phenotypes.

Explain these results in genetic terms.

(4 marks)

(b) Using defined symbols of your choice, determine the genotypes of Parents, F<sub>1</sub> progeny and F<sub>2</sub> progeny in the second experiment. (15 marks)

(c) One F<sub>2</sub> albino female dog was crossed with an F<sub>2</sub> black male. The resulting F<sub>3</sub> progeny had the following distribution: 50% albino: 37.5% Black: 12.5% brown. Investigate the genotypes of the F<sub>2</sub> progeny used in the cross and give the genotypes of all the F<sub>3</sub> 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<sub>2</sub>, 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<sub>1</sub> 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?

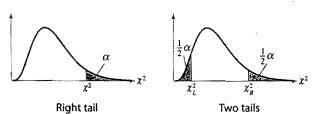
(13 marks)

[Total = 25 marks]

**END OF QUESTION PAPER** 

A19

# Table 6 — Chi-Square Distribution



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 12.388 4 0.207 0.297 0.484 0.711 1.064 7.779 9.488 11.143 13.227 14.860 5 0.412 0.554 0.831 1.145 1.610 9.236 11.071 12.833 15.086 5.750 6 0.676 0.872 1.237 1.635 2.204 10.645 12.592 14.449 16.812 18.549 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 28.999 2.1.955 9 1.735 2.088 2.700 3.325 4.168 14.684 16.919 19.023 71.666 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 5.758 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 25.999 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 32.617 38.076 41.638 44.181 24 9.886 10.856 12.401 13.848 15.659 33.196 36.781 40.289 42.796 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 49.806 10.856 12.401 13.848 15.659 33.196 36.415 39.364 42.980 45.559 30 13.787 14.994 15.73 16.151 18.114 36.741 40.113 43.194 46.963 49.645 44.4461 13.655 15.308 16.928 18.939 37.916 41.337 44.461 48.278 32.351 30.191 33.844 15.379 17.292 35.563 38.885 41.923 45.642 48.290 45.559 30.1152 44.433 26.509 29.051 51.805 55.758 59.342 22.796 30.1378 13.749 43.6960 55.534 37.855 40.882 33.699 30.915 51.805 55.758 59.342 22.796 30.1378 13.121 14.257 16.	Degrees of	α									
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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         0.884         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         6.750           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         2.929         25.188           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 </td <td>1</td> <td>_</td> <td></td> <td>0.001</td> <td>0.004</td> <td>0.016</td> <td>2.706</td> <td>3.841</td> <td>5.024</td> <td>6.635</td> <td>7.879</td>	1	_		0.001	0.004	0.016	2.706	3.841	5.024	6.635	7.879
4         0.207         0.297         0.484         0.711         1.064         7.779         9.488         11.143         13.227         14.860           5         0.412         0.554         0.831         1.145         1.610         9.236         11.071         12.833         15.096         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         28.990         21.955           9         1.735         2.088         2.700         3.325         4.66         14.684         16.919         19.023         27.566         25.589           10         2.156         2.558         3.247         3.940         4.865         15.987         18.307         20.483         23.299         25.188           11         2.603         3.053         3.816         4.575         5.5	2	0.010	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210	10.597
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         15.750           6         0.676         0.872         1.237         1.635         2.204         10.645         12.592         14.449         15.812         18.548           7         0.989         1.239         1.690         2.167         2.833         12.017         14.067         16.013         18.475         20.275           8         1.344         1.646         2.180         2.733         3.490         13.362         15.507         17.535         28.992         21.955           9         1.735         2.088         3.247         3.940         4.865         15.987         18.307         20.483         23209         25.188           10         2.156         2.558         3.247         3.940         4.865         15.987         18.307         20.483         23209         25.188           11         2.603         3.053         3.816         4.575         5.57	3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12.838
5         0.412         0.554         0.831         1.145         1.610         9.236         11.071         12.833         15.086         7.575           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         28.992         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         25.657           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	4	0.207	0.297	0.484	0.711	1.064	7.779	9.488	11.143		
7		0.412	0.554	0.831	1.145	1.610	9.236	11.071	12.833	15.086	76,750
7	6	0.676	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812	18.548
8         1.344         1.646         2.180         2.733         3.490         13.362         15.507         17.535         28.998         21.955           9         1.735         2.088         2.700         3.325         4.168         14.684         16.919         19.023         27.666         25.588           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         19675         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         31.313           15         4.601         5.229         6.262         7.261		0.989	1.239	1.690	2.167	2.833	12.017	1 1 1 1 1 1 1	. "		The state of
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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       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       8.643       9.542       10.982       12.338       14.042       30.813       33.924       36.781       40.289       42.796	12			4.404	v /* .	6.304	18.549		the second of the second of	The second of	
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       8.643       9.542       10.982       12.338       14.042       30.813       33.924       36.781       40.289       42.796		2 1			** * -		100	the second of the second of the	and the second	4.1	and the com-
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       34.70       37.566       39.997         21       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 <t< td=""><td>14</td><td></td><td>11443 294 0 23</td><td></td><td>and the second</td><td>10.0</td><td></td><td></td><td></td><td>4.1</td><td>31.319</td></t<>	14		11443 294 0 23		and the second	10.0				4.1	31.319
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		the state of the s				11 month 1971	8 1 2	- NA SER AT 1	4.74		
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