Ahmedabad University

School of Arts and Sciences

BIO310 Genetics

IMSc Programme
Mid Term Examination 2022 (Monsoon Semester)

Total Marks = 30 **Time – 1 hours 30 minutes**

Enrolment Number:.....
Date: 23-09-2022 (Exam date)
No. of printed pages: 4

Note: Please use R to perform Chi-square test where ever necessary. Please provide screen shots of your R summary which should include p-value, Chi-square value and degrees of freedom. For each problem, the screen shot should be labelled with problem no followed by student name and enrolment id. The screen shots should be uploaded to LMS folder, which will be provided by the TA before the exam.

1) In the early 1900s, Cuénot studied the genetic basis of yellow coat color in mice(discussed on pp. 107-108). He carried out a number of crosses between two yellow mice and obtained what he thought was a 3:1 ratio of yellow to gray mice in the progeny. The following table gives Cuénot's actual results, along with the results of a much larger series of crosses carried out by Castle and Little (W. E. Castle and C. C. Little. 1910. *Science* 32:868–870). **(4 points)**

Progeny Resulting from Crosses of Yellow × Yellow Mice

Investigators	Yellow progeny	Non-yellow progeny	Total progeny
Cuénot	263	100	363
Castle and Little	800	435	1,235
Both combined	1,063	535	1,598

(a) Determine whether Cuénot's results are significantly different from the 3:1 ratio that he thought he observed. Are they different from a 2:1 ratio? **(1 point)**
(b) Determine whether Castle and Little's results are significantly different from a 3:1 ratio. Are they different from a 2:1 ratio? **(1 point)**
(c) Combine the results of Castle and Cuénot and determine whether they are significantly different from a 3:1 ratio and a 2:1 ratio. **(2 points)**

2) Tatuo Aida investigated the genetic basis of color variation in the Medaka (*Aplocheilus latipes*), a small fish found in Japan (T. Aida. 1921. *Genetics* 6:554–573). Aida found that genes at two loci (*B, b* and *R, r*) determine the color of the fish: fish with a dominant allele at both loci (*B_ R_*) are brown, fish with a dominant allele at the *B* locus only (*B_ rr*) are blue, fish with a dominant allele at the *R* locus only (*bb R_*) are red, and fish with recessive alleles at both loci (*bb rr*) are white. Aida crossed a homozygous brown fish with a homozygous white fish. He then backcrossed the F_1 with the homozygous white parent and obtained 228 brown fish, 230 blue fish, 237 red fish, and 222 white fish. **(2 points)**

(a) Give the genotypes of the backcross progeny.

(b) Compare the observed numbers of backcross progeny with the number expected and provide your conclusion.

3) In some sheep, the presence of horns is produced by an autosomal allele that is dominant in males and recessive in females. A horned female is crossed with a hornless male. One of the resulting F_1 females is crossed with a hornless male. What proportion of the male and female progeny from this cross will have horns? **(2 points)**

4) In sailfin mollies fish, gold color is due to an allele (*g*) that is recessive to the allele for normal color (*G*). A gold fish is crossed with a normal fish. Among the offspring, 88 are normal and 82 are gold. **(2 points)**

(a) What are the most likely genotypes of the parents in this cross?

(b) Assess the plausibility of your hypothesis by performing a chi-square test.

5) Genes *a* and *b* are 20 cM apart. An $a^+ b^+/a^+ b^+$ individual was mated with an *a b*/*a b* individual. **(5 points)**

(a) What gametes can the F produce, and in what proportions? **(1 point)**

(b) If the F_1 was crossed to *a b*/*a b* individuals, what off- spring would be expected, and in what proportions? **(1 point)**

(c) If the F_1 were intercrossed, what offspring would be expected, and in what proportions? **(1 point)**

(d) Answer questions (a)–(c) in the preceding problem under the assumption that the original cross was $a^+ b/a^+ b \times a\ b^+/a\ b^+$. **(2 points)**

6) In silkmoths (*Bombyx mori*), red eyes (*re*) and white-banded wing (*wb*) are encoded by two mutant alleles that are recessive to those that produce wild-type traits (re^+ and wb^+); these two genes are on the same chromosome. A moth homozygous for red eyes and white-banded wings is crossed with a moth homozygous for the wild- type traits. The F1 have normal eyes and normal wings. The F1 are crossed with moths that have red eyes and white-banded wings in a testcross. The progeny of this testcross are: **(2 points)**

wild-type eyes, wild-type wings	418
red eyes, wild-type wings	19
wild-type eyes, white-banded wings	16
red eyes, white-banded wings	426

(a) What phenotypic proportions would be expected if the genes for red eyes and white-banded wings were located on different chromosomes?
(b) What is the percent recombination between the genes for red eyes and white- banded wings?

7) The type of plumage found in mallard ducks is determined by three alleles at a single locus: M^R, which codes for restricted plumage; *M,* which codes for mallard plumage; and m^d, which codes for dusky plumage. The dominance relationship between the three loci are ($M^R > M > m^d$). Give the expected phenotypes and proportions of off-spring produced by the following crosses. **(2 points)**

8) *Drosophila* females heterozygous for three recessive mutations, *a*, *b*, and *c*, were crossed to males homozygous for all three mutations. The cross yielded the following results: **(3 points)**

Phenotype	Number
+ + +	75
+ + *c*	348
+ *b c*	96
a + +	110
a b +	306
a b c	65

(a) Construct a linkage map showing the correct order of these genes and estimate the distances between them.

9) Female *Drosophila* heterozygous for three recessive mutations *e* (*ebony* body), *st* (*scarlet* eyes), and *ss* (*spineless* bristles) were testcrossed, and the following progeny were obtained: **(6 points)**

Phenotype	Number
Wild-type	67
Ebony	8
Ebony, scarlet	68
Ebony, spineless	347
Ebony, scarlet, spineless	78
Scarlet	368
Scarlet, spineless	10
Spineless	54

(a) What indicates that the genes are linked? **(1point)**
(b) What was the genotype of the original heterozygous females? **(1point)**
(c) What is the order of the genes? **(1point)**
(d) What is the map distance between *e* and *st*? **(1point)**
(e) What is the map distance between *e* and *ss*? **(1point)**
(f) What is the coefficient of coincidence and interference? **(1point)**

10) Daniel McDonald and Nancy Peer determined that eyespot (a clear spot in the center of the eye) in flour beetles is caused by an X-linked gene (*es*) that is recessive to the allele for the absence of eyespot (es^+). They conducted a series of crosses to determine the distance between the gene for eyespot and a dominant X-linked gene for striped (*St*), which causes white stripes on females and acts as a recessive lethal (it is lethal when homozygous in females or hemizygous in males). The following cross was carried out (D. J. McDonald and N. J. Peer. 1961. *Journal of Heredity* 52:261–264). **(2 points)**

$$♀\ \frac{es^+\ St}{es\ St^+} \times \frac{es\ St^+}{Y}\ ♂$$

$\downarrow$

$\frac{es^+\ St}{es\ St^+}$	1630
$\frac{es\ St^+}{es\ St^+}$	1665
$\frac{es\ St}{es\ St^+}$	935
$\frac{es^+\ St^+}{es\ St^+}$	1005
$\frac{es\ St^+}{Y}$	1661
$\frac{es^+\ St^+}{Y}$	1024

(a) Calculate the recombination frequency between *es* and *St.*
(b) Are some potential genotypes missing among the progeny of the cross? If so, which ones and why?