10

(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS

SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE OF MASTER OF SCIENCE IN PLANT BREEDING

COURSE CODE: APB 822

COURSE TITLE: ADVANCED GENETICS

DATE: 20.04.2023 **TIME:** 2-5 PM

INSTRUCTIONS TO CANDIDATES

Answer all questions in section A and any two in section B

TIME: 2 Hours

Section A (30 marks)

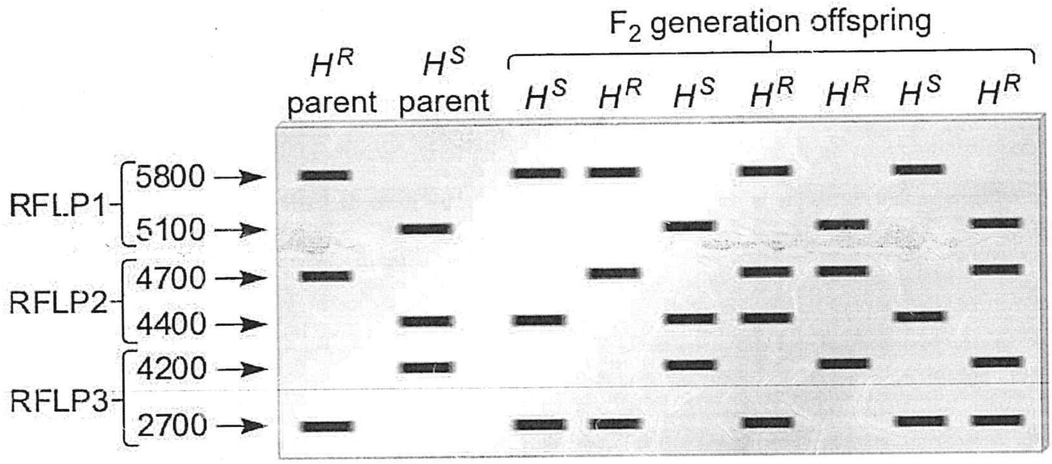
1. Describe two examples of epigenetic inheritance. **(4 marks)**

   a. In experimental organisms with a short generation time, geneticists have successfully searched for mutant alleles that prevent the normal process of embryonic development. In many cases, the offspring die at early embryonic or larval stages. These are called maternal effect lethal alleles. How would a researcher identify a mutation that produced a recessive maternal effect lethal allele? **(5 marks)**

2. Explain why an independent assortment hypothesis is used when applying a chi square approach in a linkage problem. **(4 marks)**

3. In what ways are the structures of an α helix in proteins and the DNA double helix similar, and in what ways are they different? **(4 marks)**

4. An agricultural geneticist has two strains: one that is herbicide-resistant and one that is herbicide-sensitive. The two strains differ with regard to many RFLPs. The sensitive and resistant strains are crossed, and the F1 offspring are allowed to self-fertilize. The F2 offspring are then analyzed with regard to their herbicide sensitivity and RFLP markers. The following results are obtained:



To which RFLP might the herbicide-resistance gene be linked? Justify your answer **(8 marks)**

5. How can codon bias be used to search for structural genes within uncharacterized genetic sequences? **(5marks)**

Section B (40 marks)

1. Describe the inheritance pattern of maternal effect genes. Explain how the maternal effect occurs at the cellular level. What are the expected functional roles of the proteins that are encoded by maternal effect genes? **(20 marks)**
2. Suppose that two genes are far apart on the same chromosome. A testcross is made between a heterozygous individual, AaBb, and a homozygous individual, aabb. In the heterozygous individual, the dominant alleles (A and B) are linked on the same chromosome, and the recessive alleles (a and b) are linked on the same chromosome. Draw out all of the possible double crossovers (between two, three, or four chromatids) and determine the average number of recombinant offspring, assuming an equal probability of all of the double crossover possibilities. **(20 marks)**
3. In the garden pea, orange pods (orp) are recessive to green pods (Orp), and sensitivity to pea mosaic virus (mo) is recessive to resistance to the virus (Mo). A plant with orange pods and

sensitivity to the virus was crossed to a true-breeding plant with green pods and resistance to the virus. The F_1 plants were then testcrossed to plants with orange pods and sensitivity to the virus. The following results were obtained:

160 orange pods, virus sensitive

165 green pods, virus resistant

36 orange pods, virus resistant

39 green pods, virus sensitive

400 total

a) Conduct a chi square analysis to see if these genes are linked.

b) If they are linked, calculate the map distance between the two genes

(20 marks)

N/B: probability table is provided

Chi Square Values and Probability

Degrees of Freedom	P = 0.99	0.95	0.80	0.50	0.20	Null Hypothesis Rejected 0.05	0.01
1.	0.000157	0.00393	0.0642	0.455	1.642	3.841	6.635
2.	0.020	0.103	0.446	1.386	3.219	5.991	9.210
3.	0.115	0.352	1.005	2.366	4.642	7.815	11.345
4.	0.297	0.711	1.649	3.357	5.989	9.488	13.277
5.	0.554	1.145	2.343	4.351	7.289	11.070	15.086
6.	0.872	1.635	3.070	5.348	8.558	12.592	16.812
7.	1.239	2.167	3.822	6.346	9.803	14.067	18.475
8.	1.646	2.733	4.594	7.344	11.030	15.507	20.090
9.	2.088	3.325	5.380	8.343	12.242	16.919	21.666
10.	2.558	3.940	6.179	9.342	13.442	18.307	23.209
15.	5.229	7.261	10.307	14.339	19.311	24.996	30.578
20.	8.260	10.851	14.578	19.337	25.038	31.410	37.566
25.	11.524	14.611	18.940	24.337	30.675	37.652	44.314
30.	14.953	18.493	23.364	29.336	36.250	43.773	50.892

From Fisher, R. A., and Yates, F. (1943) *Statistical Tables for Biological, Agricultural, and Medical Research.* Oliver and Boyd, London.