



AML 253: Introduction to Mathematical Tools and Modeling for the Life & Social Sciences

16.10.2023

Mock Exam, Fall 2023
Intro to Math Tools & Modeling
(Duration: 60 minutes)

Last Name: _____ First Name: _____

I confirm that I have read the following notes and that I have checked the completeness of this exam (pages 1-8).

Signature of the above-named exam attendee

Notes:

1. No additional materials are allowed.
2. Unreadable answers or answers written with a pencil can be disqualified from the evaluation.
3. Please ensure that your responses directly address the questions posed.
4. You have 60 minutes to complete the exam.

Only for the examiner:

1	2	3	-	-	-	-	-	-	total
(5)	(9)	(9)							(23)

Question 1.

(5 Points)

/ 5

Select True or False accordingly and justify your answer.

	True	False
a) The Hardy-Weinberg population genetic model's assumptions are only two: the population is very large and the mating is random.	<input type="checkbox"/>	<input type="checkbox"/>
b) The Hardy-Weinberg model is described by: $P(AA) = q$, $P(aa) = p$ and $P(Aa) = pq$.	<input type="checkbox"/>	<input type="checkbox"/>
c) If the allele b occurs with a frequency of 0.8 in a population. The frequency of genotype Bb is 0.3.	<input type="checkbox"/>	<input type="checkbox"/>
d) The Hardy-Weinberg Equilibrium is a probability of survival of one specific allele.	<input type="checkbox"/>	<input type="checkbox"/>
e) If A and B are two independent events with probabilities $P(A)$ and $P(B)$, respectively. Then $P(A \cap B) = P(A) \cdot P(B)$.	<input type="checkbox"/>	<input type="checkbox"/>

Question 2.

(9 Points)

/ 9

- (a) Use the definition of conditional probability to determine when (if ever) this statement is true: $P(A \cap B) = P(A) \cdot P(B)$. State the conditions on the events A and B. (Hint: use the equation for conditional probability)

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- (b) The probability that a person with certain symptoms has hepatitis is 0.8. The blood test used to confirm this diagnosis gives positive results for 90% of people with the disease and 5% of those without the disease. What is the probability that an individual who has the symptoms and who reacts positive to the test actually has hepatitis?

/ 2

- (c) Suppose that you have a batch of red- and white-flowering pea plants where all three genotypes, CC, Cc, and cc, are equally represented. The allele C for red flowers is dominant. You pick one plant at random and cross it with a white-flowering pea plant. What is the probability that the offspring will have red flowers?

/ 2

- (d) If two fair dice are rolled, find the probabilities of the following results.
- (a) A sum of 10, given that the sum is greater than 5.
 - (b) A “double” (two identical numbers), given that the sum is 12.
 - (c) A double, given that the sum is 11.

/ 3

Question 3.

(9 Points)

/ 9

Let p , q , and r denote the frequencies of alleles A, B, and O, respectively, in a given population for the standard blood groups. Assume random mating.

(a) What are the frequencies of each phenotype?

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(b) A study of blood types in Ecuador found the following frequencies of the phenotypes: O=75.6%, A=11.5%, B=9.5%, AB=3.4%. Find the frequencies of each allele.

/ 3

- (c) What about if we know that the frequencies for RH factor are given as follow $Rh+=34.1\%$, $Rh-=65.9\%$. What are the frequencies of each phenotype?

/ 2

- (d) Find the probability for each blood type with $Rh+$ and with $Rh-$.

/ 2

