



*(University of Choice)*

**MASINDE MULIRO UNIVERSITY OF  
SCIENCE AND TECHNOLOGY  
(MMUST)**

**MAIN CAMPUS**

**UNIVERSITY EXAMINATIONS (MAIN PAPER)**

**2022/2023 ACADEMIC YEAR**

**THIRD YEAR SECOND SEMESTER EXAMINATIONS**

**FOR THE DEGREE  
OF  
BACHELOR OF SCIENCE MEDICAL BIOTECHNOLOGY**

**COURSE CODE: BMB 324**

**COURSE TITLE: HUMAN POPULATION GENETICS**

**DATE: 24<sup>TH</sup> APRIL 2023  
02.00PM**

**TIME: 11.00 –**

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**INSTRUCTIONS TO CANDIDATES**

This paper is divided into three sections, **A B** and **C**, carrying respectively: Multiple Choice Questions (**MCQs**), Short Answer Questions (**SAQs**) and Long Answer Questions (**LAQs**). **Answer all questions. DO NOT WRITE ON THE QUESTION PAPER.**

**TIME: 2 Hours**

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 4 Printed Pages. Please Turn Over. ►

**SECTION A: Multiple Choice Questions (20 Marks)**

- The synthetic theory of evolution is based at least in part on:
  - a rejection of mutation as a source of evolution
  - an acceptance of natural selection as a cause of evolution
  - a rejection of population genetics
  - B and C
- "The sum total of the genetically inherited changes in the individuals who are members of a population" is a description of:
  - genetic drift
  - non-random mating
  - evolution
  - Natural selection
- Godfrey Hardy and Wilhelm Weinberg concluded that gene pool frequencies are:
  - inherently stable
  - inherently unstable
  - impossible to determine since we can only observe phenotypes and not genotypes
  - None of the above
- Which of the following statements is true of the Hardy-Weinberg equation ( $p^2 + 2pq + q^2 = 1$ )?
  - The "p" represents the frequency of the recessive allele for a specific trait in a population.
  - In order to use the equation, you have to know all of the genotype frequencies first.
  - The equation allows you to discover the genotype frequencies if you know the phenotype frequencies
  - None of the above
- Population geneticists now usually think of evolution as being genetic changes in:
  - individuals
  - populations
  - A and B
  - none of the above
- The Hardy-Weinberg equilibrium equation ( $p^2 + 2pq + q^2 = 1$ ) allows geneticists to:
  - Keep track of changes in phenotype frequencies from generation to generation in small families
  - keep track of changes in genotype frequencies from generation to generation in a population
  - determine what evolutionary mechanisms are causing changes in a population's gene pool frequencies
  - Population of inference
- Population genetics and the synthetic theory of evolution were developed mostly in the \_\_\_\_\_ century.
  - 17th
  - 18th
  - 19th
  - 20th
- "Synthetic theory of evolution" refers to:
  - combination of Charles Darwin's concept of natural selection along with evolutionary theories developed in the 20th century by population geneticists and molecular biologists
  - Charles Darwin's idea of evolution resulting from natural selection
  - the rigorous application of the scientific method to breeding experiments
  - Polymorphisms
- Which of the following conditions can result in evolution in a population?

- A. all mating is totally random
  - B. mutation is not occurring
  - C. natural selection is not occurring
  - D. none of the above
10. Which of the following statements is true?
- A. In the real world, gene pool frequencies are inherently unstable. That is to say, they change by themselves without any evolutionary mechanism operating.
  - B. Evolution is a common occurrence in natural populations
  - C. A gene pool is a more or less distinct group of individuals within a species who tend to restrict their mate selection to members of their group
  - D. None of the above
11. Which of the following statements is true about natural selection?
- A. It is usually the least powerful evolutionary mechanism.
  - B. Whether individuals are selected for or against by nature ultimately depends on their genotypes.
  - C. It can cause minor changes in gene pool frequencies from generation to generation but not extinctions
  - D. None of the above
12. If natural selection causes both homozygotes (AA and aa) for a trait to die in early childhood, the result for the population will be:
- A. Extinction
  - B. elimination of the recessive allele in one generation
  - C. only heterozygous individuals will survive to reproduce
  - D. Deletion
13. If natural selection is against individuals who are heterozygous (Aa) for a particular trait and it always causes death in early childhood, the result for the population will be:
- A. only homozygous individuals (AA and aa) will survive to reproduce
  - B. elimination of the recessive allele (a) in one generation
  - C. only heterozygous births will occur, which will ultimately result in extinction
  - D. Extinction of one allele
14. If natural selection is against all alleles (AA, Aa, and aa) for a particular trait and it always causes death in early childhood, the result for the population will be:
- A. gradual but steady decrease in the recessive allele (a)
  - B. elimination of the recessive allele (a) in one generation, but no effect on the dominant allele (A)
  - C. extinction in one generation
  - D. Deletion of nuclear genome
15. If nature selects only against people who are homozygous recessive (aa) for a particular trait and it always causes death in early childhood, the result for the population will be:
- A. a progressive decrease in the recessive allele (a)
  - B. an elimination of the recessive allele (a) in one generation
  - C. a gradual increase in the number of people who are heterozygous (Aa)
  - D. Extinct
16. Natural selection can cause evolution of a population's gene pool if it selects for or against:
- A. either homozygote (AA or aa) but not both
  - B. the recessive homozygote and the heterozygote (aa and Aa) but not the dominant homozygote and the heterozygote (AA and Aa)
  - C. any genotype (AA, Aa, and aa) or combination of genotypes
  - D. B and C
17. In Central Africa, nature has selected for people who:
- A. are homozygous recessive for sickle-cell trait
  - B. are heterozygous for sickle-cell trait

- C. produce only normal red blood cells
  - D. Multigene families
18. In order for a new recessive allele (created by a mutation) to be selected for or against by nature, it must:
- A. be expressed in the phenotype of an individual
  - B. appear in the genotype of an individual
  - C. be inherited by at least 10% of a population
  - D. be inherited by at least 50% of a population
19. Which of the following statements is true?
- A. Gene pool frequencies do not change as a result of migrations in or out of a population.
  - B. Gene flow occurs only as a result of migrations.
  - C. Gene flow can cause new alleles to enter a population's gene pool
  - D. None of the above
20. Which of the following cannot cause evolution?
- A. genetic drift
  - B. non-random mating
  - C. gene flow
  - D. All can cause evolution

### **SECTION B: Short Answer Questions (40 Marks)**

1. Explain the concept of advantageous alleles and selective sweep [5 Marks]
2. Outline the reasons why non-random mating occurs [5 Marks]
3. Describe how non-random mating affect populations [5 Marks]
4. Elucidate positive selection using lactose tolerance [5 Marks]
5. Elaborate on partial and antagonistic co-adaptation [5 Marks]
6. Explain how inbreeding coefficient ( $F$ ) can be measured in regular systems of inbreeding [5 Marks]
7. Outline the conditions under which Hardy-Weinberg principle models a population without evolution [5 Marks]
8. Describe five combinations of genotypes that nature can select [5 Marks]

### **SECTION C: LONG ANSWER QUESTIONS (60 MKS)**

1. Illustrate the premise of DNA replication with a mutation in the Phosphoinositide 3-Kinase autosomal gene [20 Marks]
2. Discuss the concept of repetitive DNA [20 Marks]
3. Discuss how signals for positive selection can be used to understand the loci [20 marks]