



(University of Choice)

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

MAIN CAMPUS

**UNIVERSITY EXAMINATIONS
2018/2019 ACADEMIC YEAR**

THIRD YEAR SECOND TRIMESTER EXAMINATIONS

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

COURSE CODE: BMB 324

COURSE TITLE: HUMAN POPULATION GENETICS

DATE: 29TH MAY 2019

TIME: 3.00 -5.00 PM

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**).

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 7 Printed Pages. Please Turn Over.

SECTION A: Multiple Choice Questions

1. An automated DNA sequencing machine mixes template DNA with four other components. These are:

- chain terminating nucleotides labelled with coloured dyes
- normal DNA nucleotides
- primer sequences
- *Taq* polymerase.

Which line of the table shows the functions of these components in the sequencing machine?

	chain-terminating nucleotides	normal nucleotides	primer DNA	<i>Taq</i> polymerase
A	stop replication	base-pair to template DNA	base-pairs to template DNA	joins nucleotides by phosphodiester bonds
B	stop replication	base-pair to primer DNA	base-pairs to chain-terminating nucleotides	joins bases by ester bonds
C	stop transcription	base-pair to template DNA	base-pairs to primer DNA	joins nucleotides by ester bonds
D	stop transcription	base-pair to primer DNA	base-pairs to normal nucleotides	joins bases by phosphodiester bonds

2. The deer in a captive population vary in colour. 53 deer are brown and 14 are white. The coat colour of deer is determined by the gene **R/r**, where the dominant allele **R** codes for brown and the recessive allele **r** codes for white.

Calculate the frequency of the allele **R** in the population using the Hardy-Weinberg principle.

$$p + q = 1$$

$$p^2 + 2pq + q^2 = 1$$

A 0.21

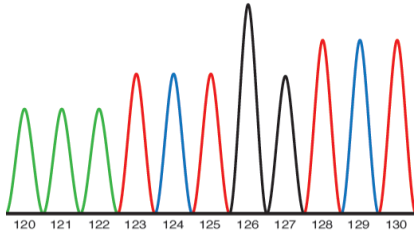
B 0.46

C 0.54

D 0.79

3. Automated sequencing uses fluorescent dyes to identify different bases in a section of DNA, as shown in the table. The diagram shows sample results for bases 120 – 130 of a certain gene.

dye colour	base
black	guanine
blue	cytosine
green	adenine
red	thymine



Which of the following statements is true?

Statement 1: The order of bases in the sequence is **AAATCTGGTTT**.

Statement 2: The base order in mRNA transcribed from this sequence is **UUUAGACCAGA**.

Statement 3: A substitution mutation affecting a base pair somewhere in this sequence could potentially affect any one of five amino acids in the resulting protein.

- A 1, 2 and 3
- B Only 1 and 2
- C Only 2 and 3
- D Only 1

4. Construction of a new road system splits a population of a rare snail species into three sub-populations, **J**, **K** and **L**. Each of these populations is reproductively isolated. The table shows the sizes of the three populations immediately after the building of the road and again ten years later. DNA analysis was used to find:

p the relative frequency of the dominant allele of a gene

q the relative frequency of the recessive allele of this gene.

The three areas of habitat remained the same as each other over the ten years.

	immediately after road building			after 10 years		
	population size	p	q	population size	p	q
J	1000	0.50	0.50	1000	0.52	0.48
K	100	0.49	0.51	100	0.63	0.37
L	10	0.40	0.60	10	0.20	0.80

Which statements are supported by this data?

Statement 1: Natural selection is occurring in populations **K** and **L**.

Statement 2: The Founder Effect is strongest in population **L**.

Statement 3: The observed allele frequency changes result from genetic drift.

- A 1, 2 and 3
- B Only 1 and 2
- C Only 2 and 3
- D Only 1

5. In a population of birds, the frequencies of genotypes for gene **H/h** differed significantly from the frequencies expected according to the Hardy-Weinberg principle.

Which reason could explain this deviation?

- A** There was no mating at random with respect to **H/h**.
- B** There was no mutation at the **H/h** gene locus.
- C** There was no migration into or out of the population.
- D** Natural selection did not favour either **H** or **h** at the expense of the other allele.

7. According to the Hardy-Weinberg principle,

- A** the allele frequencies of a population should remain constant from one generation to the next if the population is large and only sexual reproduction is involved
- B** only natural selection, resulting in unequal reproductive success, will cause evolution
- C** the square root of the frequency of individuals showing the dominant trait will equal the frequency of p
- D** p and q can only be determined for a population that is not evolving

E all of the above are correct

8. A scientist observes that the height of a certain species of asters decreases as the altitude on a mountainside increases. She gathers seeds from samples at various altitudes, plants them in a uniform environment, and measures the height of the new plants. All of her experimental asters grow to approximately the same height. From this she concludes that:

- A** height is not a quantitative trait
- B** the cline she observed was due to genetic variations
- C** the differences in the parent plants heights were due to directional selection
- D** the height variation she initially observed was an example of non-genetic environmental influence
- E** stabilizing selection was responsible for height differences in the parent plants

9. In a population with two alleles, B and b , the allele frequency of b is 0.4. What would be the frequency of the heterozygotes if the population is in Hardy-Weinberg Equilibrium?

- A** 0.16
- B** 0.24
- C** 0.48
- D** 0.6
- E** you cannot tell from this information

10. What are autosomes?

- A** sex chromosomes
- B** chromosomes that occur singly
- C** chromosomal abnormalities that result in genetic defects
- D** chromosomes found in mitochondria and chloroplasts
- E** none of the above

11. Natural selection acts most directly on...

- A** phenotypes
- B** genotypes
- C** mutations
- D** heterozygotes
- E** homozygotes

12. Sex-linked traits

- A** are carried on an autosome but expressed only in males
- B** are coded for by genes located on a sex chromosome
- C** are found in only one or the other sex, depending on the sex determination system of the species
- D** are always inherited from the mother in mammals and fruit flies

E depend on whether the gene was inherited from the mother or the father

13. A wild type is

A the phenotype found most commonly in nature

B the dominant allele

C designated by a small letter if it is recessive or a capital letter if it is dominant

D a trait found on the X chromosome

E your basic party animal

14. The greatest source of genetic variation in plant and animal populations is from

A mutations

B sexual reproduction

C selection

D geographic variation

E recessive masking in heterozygote

15. What is a karyotype?

A a genotype of an individual

B a pictorial display of individual's chromosomes

C a blood type determination of an individual

D a unique combination of chromosomes found in a gamete

E a species-specific diploid number of chromosomes

16. The polymerase chain reaction (PCR) is a laboratory technique used to amplify DNA. Which statements correctly describe aspects of this process?

Statement 1: When the temperature is at 55°C single-stranded DNA anneals to primers.

Statement 2: DNA copy number increases with each thermal cycle on a logarithmic scale.

Statement 3: The enzyme *Taq* polymerase is used because it catalyses transcription in a bacterium that lives in hot water.

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

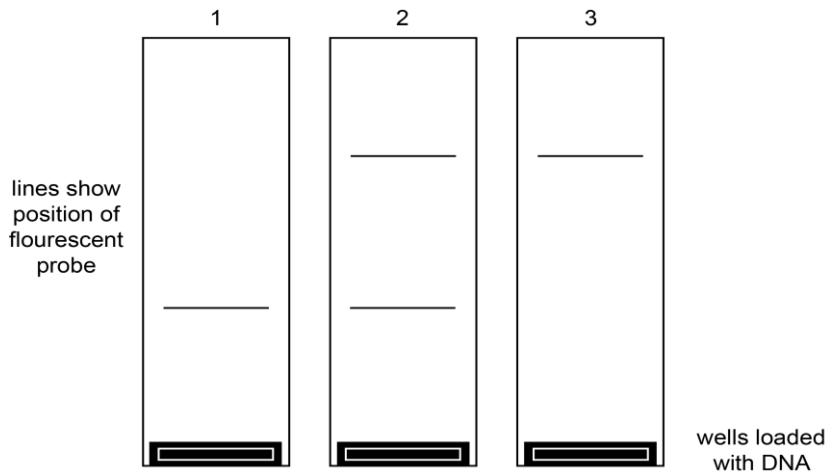
17. The β -globin gene codes for a polypeptide in haemoglobin. An individual with the disease sickle cell anaemia has two copies of a recessive allele of this gene. A genetic test can distinguish between the normal and sickle cell alleles.

- A restriction digest of normal DNA gives a 7.6 kbp fragment that contains the normal β -globin allele.

- The same restriction digest gives a 13 kbp fragment if the sickle cell allele is present instead of the normal β -globin allele.

After restriction digestion, the fragments are separated by electrophoresis. A fluorescent DNA probe is used to show the location of the fragments on the gel.

The diagram shows results for three individuals.



Which individual(s) suffer from sickle cell anaemia?

18. Mutations are rarely a direct source for microevolution in eukaryotes because
- A** they are most often harmful and do not get passed on
 - B** they do not directly produce most of the genetic variation present in a diploid population
 - C** they occur very rarely
 - D** they are only passed on when they occur in gametes
 - E** all of the above
19. Two men who are identical twins marry two women who are also identical twins. Each couple has a daughter. The daughters are more genetically similar than is usual for first cousins.
- Which statement describes the degree of genetic similarity between the daughters?
- A** They are genetically different from each other due to independent assortment in meiosis.
 - B** They are genetically different from each other due to random mutation.
 - C** They are genetically identical because random mutation is rare.
 - D** They are genetically identical because they share the same parental gene pool.
20. Pairs of homologous chromosomes
- A** have identical DNA sequences in their genes
 - B** have genes for the same characters at the same loci
 - C** are found in gametes
 - D** separate in meiosis II
 - E** have all of the above characteristics

SECTION B: Short answer questions

1. Differentiate between transversion and transition as used in genetics. (4 marks).
2. Compare and contrast Deoxyribonucleic acid and Ribonucleic acid (4 marks).
3. a) State the Hardy-Weinberg equilibrium (2marks).
b) Briefly explain the assumptions of the Hardy-Weinberg equilibrium (10 marks).
4. a) The DNA sequence of a gene from three independently isolated mutants is given below.
Mutant 1: ACCGTAATCGACTGGTAAACTTTGCGCG
Mutant 2: ACCGTAGTCGACCGGTAAACTTTGCGCG
Mutant 3: ACCGTAGTCGACTGGTAAACTTTGCGCG
Using this information, what is the sequence of the wild type gene in this region? (6 marks).

b) Arrange the following statements in the appropriate order for determining whether a specific allele is present in a person's DNA (4 marks).

- a. Amplify the DNA using PCR
- b. Label the probe DNA
- c. Isolate the sample DNA from an individual
- d. Hybridize with the relevant probe
- e. Divide the DNA sample from an individual into two

SECTION C: Essay questions

1. Discuss the various factors that can lead to the disruption of Genetic equilibrium in any given population. (20 marks).
2. With the help of examples differentiate between the following terminologies (10 marks)
 - i. Stabilising selection
 - ii. Disruptive selection
 - iii. Directional selection
 - iv. Sexual selection