"Investing in Africa's Future"

COLLEGE OF HEALTH, AGRICULTURE AND NATURAL SCIENCES

DEPARTMENT OF BIOMEDICAL AND LABORATORY SCIENCES

BACHEOR OF MEDICAL LABORATORY SCIENCES HONOURS DEGREE

MLS 1102: GENETICS AND MOLECULAR DIAGNOSTICS

END OF SEMESTER FINAL EXAMINATIONS

NOVEMBER 2025

LECTURER: DR S L MUTAMBU

DURATION: 3 HOURS

INSTRUCTIONS

1. Write your candidate number on the space provided on top of each page.
2. Answer **all** questions in section A on the question paper.
3. Answer **all** questions in section B on separate answer sheets provided.
4. Answer any **3** questions in section C on separate answer sheets provided
5. Mark allocation for each question is indicated at the end of the question
6. Credit will be given for logical, systematic and neat presentations in sections B and C

SECTION A : MULTIPLE CHOICE [20 MARKS]

- **Answer all questions by encircling the correct response T for TRUE or F for FALSE for each statement in all the questions**
- **Each correct response is allocated quarter mark.**

1. The Human Genome:

T F **a)** is arranged on 23 pairs of chromosomes.
T F **b)** has twenty-two pairs called autosomes.
T F **c)** also has one pair called the F chromosome.
T F **d)** humans have 23 pairs of chromosome in every cell except for mature red blood cells.

2. Regarding protein synthesis:

T F **a)** the enzyme DNA polymerase is responsible for synthesizing RNA.
T F **b)** mRNA is translated into protein at the ribosome.
T F **c)** introns are non-coding regions removed during RNA splicing.
T F **d)** the genetic code is universal across almost all organisms.

3. Genes:

T F **a)** are pieces of RNA containing information for the synthesis of DNA.
T F **b)** are made from a large molecule called Ribonucleic Acid.
T F **c)** are unique form of a single gene called an allele.
T F **d)** undergo random changes that can create new alleles called mutations.

4. Genes make protein:

T F **a)** and are expressed by being transcribed into RNA.
T F **b)** this RNA is then translated into protein.
T F **c)** and transcription is controlled by other DNA sequences such as promoters.
T F **d)** made of a chain of 24 different types of amino acid molecules.

5 Concerning Genes and inheritance:

T F **a)** all genes are expressed at all times in every cell.
T F **b)** genes are inherited as units from two parents.
T F **c)** humans have four copies each, of each gene.
T F **d)** offspring formed has the same number of genes as the parents.

6. Genetic traits:

T F **a)** can be part of an organism's physical appearance.
T F **b)** may not be easily seen e.g. blood types.
T F **c)** can be inherited through blood.
T F **d)** can come from interactions between genes and the environment.

7. Shown below are differences between prokaryotic and eukaryotic translation:

T F **a)** monocistronic and polycistronic, respectively
T F **b)** initiation – Shine Dalgano sequence vs Kozak sequence
T F **c)** speed of translation
T F **d)** half-life of mRNA

8. Single Gene mutation:

T F **a)** can occur due to environmental factors like radiation or chemicals.
T F **b)** can also occur during DNA replication.
T F **c)** can be passed on to offspring.
T F **d)** is a diseased state that occurs if the mutation leads to malfunctioning proteins.

9. A Eukaryotic cell has:

T F **a)** a true nucleus, where the genetic material is surrounded by a membrane.
T F **b)** a genome that is more complex than that of prokaryotes and distributed on a single chromosome.
T F **c)** a circular DNA.
T F **d)** DNA which is complexed with proteins called histones.

10. Concerning DNA:

T F **a)** it consists of two long polymers of simple units called nucleotides.
T F **b)** nucleotides are made of a base, sugar and phosphate group.
T F **c)** the types of bases in DNA are adenine, guanine, cytosine and thymine.
T F **d)** uracil takes the place of cytosine in RNA.

11. Listed below are tools needed for mRNA translation into protein:

T F **a)** ribosomes
T F **b)** mRNA
T F **c)** tRNA
T F **d)** amino acids

12. Gene expression is a:

T F **a)** process by which a gene gets turned on in a cell to transcribe RNA and produce proteins.
T F **b)** process by which the instructions in DNA are converted into a functional protein.
T F **c)** process called induced expression where some genes are expressed at lower levels.
T F **d)** process by which information from a gene is used in the synthesis of a functional gene product.

13. Biotechnology:

T F **a)** is the use of living organisms, or substances/systems obtained from living organisms to produce products or processes of value to humankind.
T F **b)** can be applied in different sectors of the productive economy.
T F **c)** principles of ethics also apply to biotechnology.
T F **d)** stem cell therapy is an emerging trend of biotechnology.

14. The following are tools used in Biotechnology:

T F **a)** Recombinant Nucleic Acid Technology
T F **b)** Microarrays and Nucleic Acid Probes
T F **c)** Gene banking
T F **d)** Gene slicing

15. Techniques and tools used in molecular diagnostics:

T F **a)** Real-time PCR allows quantification of DNA during amplification.
T F **b)** Southern blotting is used to detect RNA molecules.
T F **c)** CRISPR technology has no role in molecular diagnostics.
T F **d)** Next-generation sequencing (NGS) can identify multiple genetic mutations simultaneously.

16. Applications of molecular biology include:

T F **a)** disease diagnosis
T F **b)** production of therapeutic drugs
T F **c)** crime and forensics
T F **d)** paternity testing

17. Regarding applications and ethics in molecular diagnostics:

T F **a)** molecular diagnostics can help identify carriers of recessive genetic disorders.
T F **b)** genetic testing results are always straightforward and easy to interpret.
T F **c)** molecular diagnostics can guide personalized treatment plans in precision medicine.
T F **d)** ethical considerations are important when dealing with predictive genetic testing.

18. Tools and terms used in recombinant DNA include:

T F **a)** vectors
T F **b)** host cells
T F **c)** cloning
T F **d)** transformation

19. Concerning Sickle Cell Anemia:

T F **a)** it is caused by a point mutation in the HBB gene.
T F **b)** it can be detected using molecular techniques.
T F **c)** PCR and restriction enzyme analysis can be used to detect the sickle cell mutation.
T F **d)** carrier screening for sickle cell anemia is important in low- risk populations.

20. Below are basic concepts in molecular diagnostics:

T F **a)** molecular diagnostics involve analyzing DNA, RNA, or proteins to detect genetic disorders
T F **b)** all genetic diseases can be diagnosed using a single molecular technique.
T F **c)** molecular diagnostics can only be performed post-natally.
T F **d)** mutations in the BRCA1 and BRCA2 genes are detected using molecular diagnostics to assess breast and ovarian cancer risk.

SECTION B [20 MARKS]
Answer all questions on separate answer sheets provided

1. List any five (5) blotting techniques and what they are used to detect or analyse in Biotechnology. (5 marks)
2. State five (5) reasons why the control of gene expression is much more complex in eukaryotes than in prokaryotes. (5 marks)
3. Name five (5) applications of recombinant DNA techniques. (5 marks)
4. Name the five (5) pillars of Biomedical Ethics. (5 marks)

SECTION C [60 marks]
Answer any 3 questions from this section on separate answer sheets provided

1. Regulation of gene expression in eukaryotes can occur at any stage as DNA is transcribed into mRNA and mRNA is translated into protein.

Discuss in detail the processes of:

a) Epigenetic control of gene expression (10 marks)
b) Post translational control of gene expression (10 marks)

2. Define DNA library and describe in detail the procedure for the construction of a cDNA library. (20 marks)
3. Discuss in detailed the Polymerase Chain Reaction and its application in the medical laboratory. (20 marks)
4. Give a detailed account of the *lac* operon as a model for gene regulation in *E coli*. (20 marks)
5. Illustrate and discuss the use of recombinant DNA technology in the production of Growth Hormone. (20 marks)

THE END