NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Faculty of Health, Natural Resources and Applied Sciences

School of Natural and Applied Sciences

Department of Biology, Chemistry and Physics

13 Jackson Kaujeua Street
Private Bag 13388
Windhoek
NAMIBIA

T: +264 61 207 2012
F: +264 61 207 9012
E: dbcp@nust.na
W: www.nust.na

QUALIFICATION: **BACHELOR OF SCIENCE**	
QUALIFICATION CODE: **07BOSC**	LEVEL: **6**
COURSE: **GENETICS**	COURSE CODE: **GEN602S**
DATE: **NOVEMBER 2024**	SESSION: **1**
DURATION: **3 HOURS**	MARKS: **100**

FIRST OPPORTUNITY: QUESTION PAPER

EXAMINER: *Prof Edosa Omoregie*

MODERATOR: *Dr Jeya Kennedy*

INSTRUCTIONS

1. Answer all questions on the separate answer sheet.
2. Please write neatly and legibly.
3. Do not use the left-side margin of the exam paper. This must be allowed for the examiner.
4. No books, notes and other additional aids are allowed.
5. Mark all answers clearly with their respective question numbers.

PERMISSIBLE MATERIALS:

1. Non-Programmable Calculator

ATTACHMENTS

None

This paper consists of 6 pages, including this front page

SECTION A: MULTIPLE CHOICE [20 MARKS]

QUESTION 1: MULTIPLE CHOICE QUESTIONS [20 MARKS]

Evaluate the statements in each numbered section and select the most appropriate answer from the given possibilities. Fill in the appropriate letter next to the number of the correct statement/phrase on your ANSWER SHEET. [20]

1.1 What is the primary function of mitosis in multicellular organisms?
a) Genetic recombination
b) Production of gametes
c) Tissue growth and repair
d) Creation of genetic diversity
e) Mutation correction

1.2. During meiosis, what is the key significance of crossing over in Prophase I?
a) Error correction in DNA replication
b) Restoration of diploid chromosome number
c) Equal distribution of organelles
d) Increased genetic diversity
e) Formation of centromeres

1.3. In the context of inheritance, how does incomplete dominance differ from Mendelian inheritance?
a) Both alleles are completely expressed in incomplete dominance
b) Incomplete dominance results in a phenotypic blend of both parental traits
c) In Mendelian inheritance, the recessive allele is always expressed
d) In Mendelian inheritance, both alleles are dominant
e) Incomplete dominance only occurs in autosomal chromosomes

1.4. During DNA synthesis, the addition of a new nucleotide to a newly formed DNA strand always proceeds in which direction?
a) From the promoter
b) In either direction
c) In the 3' to 5' direction
d) In the 5' to 3' direction
e) None

1.5. In a flower colour gene where incomplete dominance occurs, crossing a red-flowered plant with a white-flowered plant produces pink flowers. What will the phenotypic ratio be if two pink-flowered plants are crossed?
a) 1:2:1 (red: pink: white)
b) 3:1 (pink: white)
c) 1:1 (red: pink)
d) 9:3:3:1 (red: pink: white: yellow)
e) None, as incomplete dominance does not follow ratios

1.6. How does epistasis differ from incomplete dominance in genetic expression?
a) Epistasis involves multiple genes while incomplete dominance involves a single gene
b) Both involve a blending of phenotypes
c) Epistasis suppresses the effect of another gene while incomplete dominance shows partial dominance
d) Epistasis involves only sex-linked genes
e) Both only occur in autosomal genes

1.7 Which of the following statements best describes the semi-conservative model of DNA replication?
a) Each of the two daughter molecules has one old strand and one new strand
b) Both daughter molecules have completely new DNA
c) The entire DNA strand is replicated twice
d) Replication occurs only on one strand
e) DNA replication is bidirectional

1.8. Which type of mutation is likely to cause a shift in the reading frame of a gene?
a) Point mutation
b) Insertion
c) Substitution
d) Silent mutation
e) Missense mutation

1.9. What is the main consequence of a nondisjunction event during meiosis?
a) Deletion of genes
b) Duplication of genetic material
c) Production of gametes with abnormal chromosome numbers
d) Inversion of chromosomal segments
e) Translocation of chromosome parts

1.10. Down syndrome is caused by which chromosomal abnormality?
a) Monosomy 18
b) Trisomy 21
c) Deletion of chromosome 7
d) Inversion of chromosome 13
e) Duplication of chromosome 19

1.11 What is the role of RNA polymerase II in gene transcription?
a) It synthesizes transfer RNA (tRNA)
b) It transcribes all protein-coding genes
c) It adds poly-A tails to mRNA
d) It regulates RNA splicing
e) It initiates DNA replication

1.12. How do transcription factors regulate gene expression?
a) By degrading mRNA in the cytoplasm
b) By binding to DNA and controlling the rate of transcription

c) By attaching ribosomes to the mRNA for translation
d) By modifying the structure of DNA
e) By regulating protein folding post-translation

1.13. Which of the following describes an operon?
a) A sequence of DNA that encodes multiple transcription factors
b) A group of genes controlled by a single promoter
c) A protein that initiates gene transcription
d) A sequence of nucleotides that terminates transcription
e) A non-coding RNA that regulates gene expression

1.14. Which of the following statements about transposons during gene recombination is not true?
a) During transposition, a short sequence of target DNA is duplicated, and the transposon is inserted between the directly repeated target sequences
b) Some transposons insert into almost any target DNA sequence
c) The actions of transposases go on indefinitely without interruption
d) Transposons are important genetic elements because they cause mediate genomic rearrangement
e) All of the above statements

1.15. Which of the following is a key assumption of the Hardy-Weinberg equilibrium?
a) No random mating occurs
b) No mutation takes place in the population
c) The population size is extremely small
d) Natural selection actively influences allele frequencies
e) Migration of individuals is frequent

1.16. What is the bottleneck effect in population genetics?
a) An increase in population size that promotes genetic diversity
b) A rapid loss of genetic variation due to a drastic reduction in population size
c) The preferential survival of individuals with advantageous traits
d) The accumulation of deleterious alleles in a population
e) The formation of new species from isolated populations

1.17. Which of the following best explains the founder effect?
a) A population rapidly expands in size, increasing genetic diversity
b) A small group establishes a new population with limited genetic variation
c) Natural selection causes a shift in allele frequencies within a population
d) Mutations introduce new genetic variations into a population
e) Gene flow from neighbouring populations increases genetic diversity

1.18. Which of the following best describes the process of gene splicing?
a) Cutting DNA fragments from multiple organisms and combining them into a single plasmid
b) Inserting a cloned embryo into a surrogate for growth
c) Selectively breeding two organisms with desirable traits

d) Utilizing CRISPR to inhibit gene expression
e) Replicating an organism's DNA to create an identical clone

1.19. Which of the following best explains how genetically modified organisms (GMOs) are created using recombinant DNA technology?
a) By naturally selecting organisms that mutate their genes over time
b) By inserting plasmids containing foreign DNA into bacterial cells, allowing the cells to express new traits
c) By hybridizing two genetically distinct species to produce a hybrid organism
d) By using gel electrophoresis to separate and analyze DNA fragments for sequencing
e) By using radiation to induce mutations that change the organism's genetic structure

1.20. In the process of creating transgenic organisms, which step is crucial for ensuring the successful insertion of foreign genes?
a) Hybridizing two species with desirable traits
b) Amplifying the target gene using polymerase chain reaction (PCR)
c) Removing the nucleus from a fertilized egg
d) Crossing the organism with another that shares the same genetic traits
e) Inserting the desired gene into the 5' untranslated region of the chromosome

SECTION B: ESSAY QUESTIONS [80 MARKS]

Please answer ANY FOUR of the questions in this section.

QUESTION 2

2.1. Using suitable molecular diagrams, discuss the structure of the DNA double helix, including its subunits and how they are bonded together, indicating the antiparallel arrangements of the polynucleotide strands. (14)
2.2. With the aid of illustrations, discuss the processes of substitution, insertion, and deletion in gene mutation. (6)

QUESTION 3

3.1. With suitable diagrams, briefly describe the process of mitotic division in a eukaryotic cell, emphasising the changes on the chromosome. (12)
3.2. Analyze the differences between codominance and incomplete dominance, using relevant examples to explain how phenotypes differ in offspring. (8)

QUESTION 4

4.1. Describe the synthesis of new DNA and explain the roles of the various enzymes involved in synthesising new DNA strands from the parent DNA strand. (10)
4.2. Briefly explain the molecular structure of transfer RNA and highlight the main structural differences between RNA and DNA molecules. (8)
4.3. Briefly explain the primary function of ribosomal RNA. (2)

QUESTION 5

5.1. Explain the central dogma of gene expression and how gene expression is regulated at the transcriptional and post-transcriptional levels. (10)

5.2. With the aid of diagrams, explain the role of transposons and transposase in genetic recombination. Why are transposons referred to as important genetic materials in organisms? (6)

5.3. Using schematic diagrams, differentiate intermolecular and intramolecular gene recombination. (4)

QUESTION 6

6.1. Define the term microevolution based on genetic principles. (2)

6.2. Discuss the key assumptions of the Hardy-Weinberg equilibrium and explain how violations of these assumptions can lead to changes in allele frequencies over time. (8)

6.3. With the aid of graphic illustrations, briefly explain the effects of directional, disruptive, and stabilizing natural selections on population evolution. (10)

END OF QUESTION PAPER