FACULTY	AGRICULTURE AND NATURAL RESOURCES		
DEPARTMENT	ANIMAL PRODUCTION, AGRIBUSINESS & ECONOMICS		
SUBJECT	MOLECULAR GENETICS		
SUBJECT CODE	F3532AG		
DATE	NOVEMBER 2023		
DURATION	3 HOURS	Marks	100

FIRST OPPORTUNITY EXAMINATION MEMORANDUM

Examiner: Prof. T.O. Amushendje & Ms Lavinia Haikukutu
Internal moderator: Dr. E. Lutaaya
External moderator: Prof. E. Bhebhe

This question paper consists of **six (6)** pages including this front page.
Additional materials to be supplied: **Genetic code**

Instructions

This question paper consists of **five (5)** questions. Attempt **all of them.**
All questions carry equal marks (i.e. 20 marks each).
You may use a calculator.

UNIVERSITY OF NAMIBIA EXAMINATIONS

QUESTION ONE **[20]**

Multiple choice questions, select the correct answer(s). For some questions, there might be more than one correct answer. Each question is worth 1 mark.

1. A missense mutation causing the substitution of a chemically different amino acid is referred to as
A. Synonymous substitution
B. Silent substitution
C. Nonsense mutation
D. Non-synonymous substitution
E. Frameshift mutation

2. A geneticist crosses a red koi carp (ornamental fish) with a white koi carp. The offspring include fish with red color (1/4), pink color (1/2), and white color (1/4). Which allele is dominant?
A. Red
B. White
C. Neither, they are co-dominant
D. Neither, they are incompletely dominant
E. Both red and white are dominant

3. Which of the following karyotype is a male in birds?
A. ZZ
B. ZW
C. WW
D. XY
E. None of the above is correct

4. In RNA, _____ codon(s) translate to _____ amino acid(s)
A. One, one
B. Three, one
C. Three, three
D. One, six
E. Two, one

5. If individual X has the genotype (aabbccdd) and individual Y has the genotype (AABBCCDD). When individuals X and Y marry, what is the probability of producing a child that will phenotypically resemble individual X?
a. 0.5
b. 0
c. 1
d. 0.25

6. Interactions among the human ABO blood group alleles involve:
a) Co-dominance; complete dominance
b) Co-dominance; incomplete dominance
c) Epistasis; complementation
d) Complete dominance; incomplete dominance

7. Barr bodies are
(a) Genetically inactive X chromosomes in "normal" males
(b) Genetically inactive X chromosomes in "normal" females
(c) Genetically inactive Y chromosomes in "normal" males
(d) Genetically inactive Y chromosomes in "normal" females
(e) Both (a) and (b) are correct

8. A woman who is colour-blind (X-linked recessive) and has a straight hairline (autosomal recessive) has a daughter with a man who is not colour blind, but also has straight hairline. Which could be the genotype of their daughter?
A) bbww
B) X^bYWw
C) X^BX^bww
D) X^wX^wBb
E) XYWw

9. In mammals, five genes (A, B, C, D & S) interact to produce Coat colour. What is the colour of an individual whose genotype is: (aabbCcDdss)?
a. Dilute brown with piebald or spotting pattern
b. Brown with piebald or spotting pattern
c. Dilute agouti, no spotting pattern
d. Dilute black with piebald or spotting pattern
e. Agouti with piebald or spotting pattern

10. In fruit fly, which of the following genotypes is a female individual?
A. XO
B. YO
C. XY
D. XXY
E. None of the above are correct

11. There are how many tRNA molecules?
a. 45
b. 64
c. 61
d. 20
e. 4

12. Which of the following alleles is lethal in rabbits?
A. Chinchila allele
B. Himalayan allele
C. Albino allele
D. Manx allele

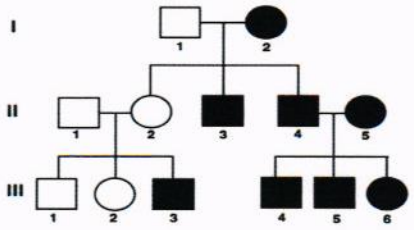
13. A set of alleles of closely linked loci on a chromosome that tend to be inherited together is termed as
(a) A gene cluster
(b) A haplotype
(c) A map unit
(d) A CentiMorgan
(e) A recombinant

14. During what stage of the cell cycle does DNA replication occur?
a) Gap1 (G1),
b) Synthesis (S)
c) Gap2 (G2)
d) Mitosis (M)

15. Which of the following statements is true regarding the organization of genetic material in prokaryotic and eukaryotic cells?

a) Prokaryotic cells have a single, circular chromosome, while eukaryotic cells have multiple linear chromosomes.
b) Prokaryotic cells have multiple linear chromosomes, while eukaryotic cells have a single, circular chromosome.
c) Prokaryotic cells contain large amounts of noncoding and repetitive DNA.
d) Both prokaryotic and eukaryotic cells have multiple linear chromosomes.

16. The pedigree below tracks Duchenne Muscular Dystrophy (DMD) through several generations. DMD is an X-linked recessive trait.



If individual II-3 has a child with an affected woman, what is the percent chance that the child will be a *daughter* with DMD?

A. 0%
B. 25%
C. 50%
D. 75%
E. 100%

17. What percentage of *mp / mp* (homozgyous recessive) offspring will be produced from a cross between *Mp / mP* and *mp / mp* if loci *M* and *P* are 16 map units apart?

a) 16%
b) 42%
c) 25%
d) 8%

18. What is the purpose of loading dye in gel electrophoresis?

a) To visualize the gel under UV light
b) To increase the conductivity of the sample
c) To stain the DNA for permanent record-keeping
d) To increase the density of the sample

19. What is the primary technique used in animal cloning, such as the cloning of Dolly the sheep?

a) Polymerase Chain Reaction (PCR)
b) Somatic Cell Nuclear Transfer (SCNT)
c) In Vitro Fertilization (IVF)
d) Gene Knockout

20. In recombinant DNA technology, what is the purpose of a plasmid?

a) To amplify DNA fragments
b) To cut DNA into smaller pieces
c) To introduce foreign DNA into a host organism
d) To sequence DNA

QUESTION TWO [20]

a) Write short notes on the following terms:

i. Sex reversal in humans [4]

ii. Sex linkage [4]

b) A portion of the template strand of a DNA molecule has the sequence:

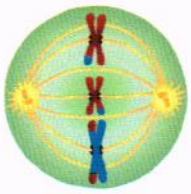
3' TACCTTAGTAACGTA 5'

i. Give the sequence of the mRNA strand sequence and show the polarity. [2]

ii. What is the amino acid sequence of the polypeptide encoded in this DNA region? [4]

iii. Give the sequence and the polarity of the coding strand of this DNA molecule. [2]

c) The cell below was stained while being at Metaphase II of Meiosis II.

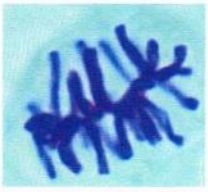


i. What is 2*n* in this organism? [1]

ii. How many chromosomal combinations are possible in this species? [1]

d) In which stage of mitosis are the cells below? [2]

i. 

ii. 

QUESTION THREE [20]

a) A woman with normal vision whose father was colour-blind (X-linked recessive) mates with a man with normal vision. They have a colour-blind daughter with Turner's syndrome. In which parent did non-disjunction occur? Explain! [4]

b) A codon on the mRNA was: CUG, while the tRNA on the anticodon of the tRNA was GAU. Explain. [4]

c) Explain why the tortoiseshell coat is only observed in female cats, and not in male cats. [4]

d) Discuss the Lac Operon proposed by François Jacob & Jacques Monod to explain gene regulation in prokaryotes with reference to:

(i) when lactose is present and glucose is absent [4]

(ii) when lactose is absent and glucose is present [4]

QUESTION FOUR

a) Describe the enzymology of DNA replication (i.e. enzymes and proteins involved in DNA replication and their functions). **[12]**

b) Describe two uses of recombinant DNA technology in animal science **[4]**

c) Suppose if the recombination frequency between two genes present on the same chromosome 'q' and 'r' is 13%, 'p' and 'r' is 2%, 'q' and 's' is 4%, 'q' and 'p' 15%, and 'r' and 's' is 17%. Based on these frequencies, identify the correct sequence of genes on the chromosome. Draw a map showing the position and distance between the loci. **[4]**

QUESTION FIVE

Describe in detail the technique of polymerase chain reaction (i.e. definition, components, steps) and its application in your field of study. **[20]**

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GENETIC CODE

1st letter	Second Letter: U	Second Letter: C	Second Letter: A	Second Letter: G	3rd letter
U	UUU Phe UUC UUA Leu UUG	UCU UCC UCA Ser UCG	UAU Tyr UAC UAA Stop UAG Stop	UGU Cys UGC UGA Stop UGG Trp	U C A G
C	CUU CUC Leu CUA CUG	CCU CCC Pro CCA CCG	CAU His CAC CAA Gln CAG	CGU CGC Arg CGA CGG	U C A G
A	AUU AUC Ile AUA AUG Met	ACU ACC Thr ACA ACG	AAU Asn AAC AAA Lys AAG	AGU Ser AGC AGA Arg AGG	U C A G
G	GUU GUC Val GUA GUG	GCU GCC Ala GCA GCG	GAU Asp GAC GAA Glu GAG	GGU GGC Gly GGA GGG	U C A G