GWANDA STATE UNIVERSITY

FACULTY OF LIFE SCIENCES

DEPARTMENT OF ANIMAL SCIENCE

BACHELOR OF SCIENCE HONOURS DEGREE IN ANIMAL SCIENCE/CROP SCIENCE

Molecular Biology

LAS 1107

First Semester Final Main Examination Paper

FEBRUARY 2022

This examination paper consists of 7 pages

Time Allowed: **3 hours**

Total Marks: **100**

Special Requirements: **None**

Examiner's Name: **Miss A. Banda**

INSTRUCTIONS

1. Answer **all** questions in Section A
2. Answer **only two** questions in Section B

MARK ALLOCATION

QUESTION	**MARKS**
SECTION A	**60**
SECTION B	**40**
TOTAL ATTAINABLE MARKS	**100**

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION 1

a. Calculate the percent content of each of the bases for the following organisms. Deduce the information based on the provided data. **[5 marks]**

Table 1: Percentage content of bases in different organisms

Organism	Guanine (G)	Cytosine (c)	Thymine (T)	Adenine (A)
Streptomyces coelicolor		38%		
Saccharomyces cerevisiae			19%	
Arabidopsis thaliana	18%			
Plasmodium falciparum				30%

b. Draw the complementary sequence for the following single strand of DNA.
5'CTA TCG ATT CAA CGA AAT TCG CAA GGC ATT 3' **[5 marks]**

c. Transcribe the double-stranded DNA from question **1b** into a single-stranded mRNA using the top strand as the template. **[5 marks]**

d. Translate the mRNA from question **1b** into protein using the codon chart. **[5 marks]**

QUESTION 2

a. Define genes. **[2 marks]**

b. Explain how regulatory genes and alleles complicate the issue of genetic traits. **[6 marks]**

c. Determine the potential phenotype(s) for the offspring of a female with dominant red flowers (RR) and purple stem (PP) and a male with recessive white flowers (rr) and all green stems (pp). Using the checkerboard diagram of Punnett square, determine all the potential genotypes for the F2 generation if the F1 was to self-cross.

[12 marks]

QUESTION 3

Since the genetic code is degenerate, more than one triplet codon adds the same amino acid during translation. List all the possible mRNA sequences that could code for these amino acids

a. Met-Ser-Asn [**4 marks]**
b. Val-His-Phe [**10 marks]**
c. Trp-Glu-Tyr [**6 marks]**

SECTION B: ANSWER <u>ONLY TWO</u> QUESTIONS

QUESTION 4

a. Define transcription and name an enzyme that makes the transcripts. [**3 marks]**
b. State the three RNA polymerase enzymes and briefly describe their transcription products in Eukaryotes. [**8 marks]**
c. RNA polymerase I, II, III have varying levels of sensitivity to the poison called α-amanitin, which is from the mushroom Amanita phalloides. RNA polymerase II, is completely sensitive to the poison; RNA polymerase III has intermediate sensitivity; and RNA polymerase I is insensitive to the poison. What would happen to transcription of the rRNA genes, tRNA genes, and the gene for the glucose transporter if a eukaryote was poisoned with α-amanitin?

[**9 marks]**

QUESTION 5

a. Many plants are polyploids (>2n) chromosomes. Polyploids have often been selected among domesticated crop plants, since they tend to give bigger plants with higher yields (Table 2) Copy and complete table 2, wheat information has been provided for you. [**6 marks]**

Table 2: Ancestral Haploid, chromosome number (No.) and ploidy level

Plant	Ancestral Haploid No.	Chromosome No.	Ploidy level
Wheat	7	42	6n
Domestic	-	42	6n
Peanut	10	-	4n
Sugarcane	10	80	-
White potato	12	-	4n
Tobacco	-	48	4n
cotton	13	52	-

b. Using data of bacterial cell growth in Table 3 below, plot a graph (time on the X-axis; No. of cells on the Y-axis and determine the approximate doubling time for each growth condition.

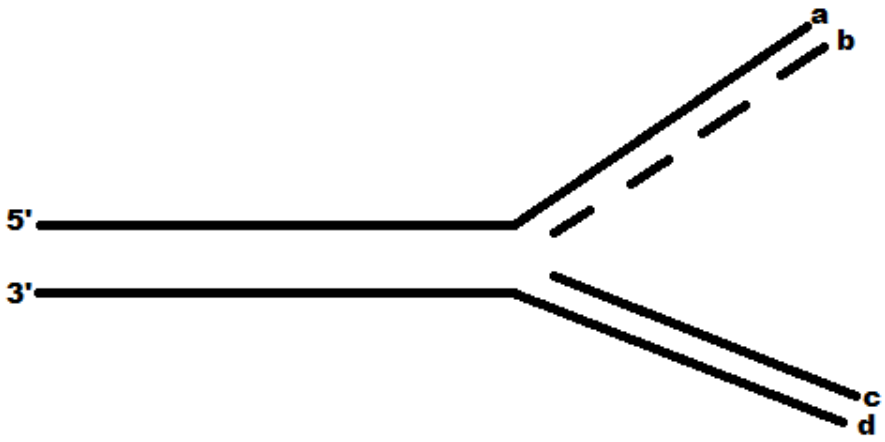
Table 3: Bacterial cell growth data (nX10^8 cells/ml)

Time	Minimal media	Normal media	Rich media
10	1	1.3	1.3
20	1.3	1.7	2
30	1.6	2.5	3
40	1.8	3.7	4.4
50	2.4	4.5	7.8
60	3	6	12
70	3.9	8	18
80	4.8	12	19
90	6	15.8	19.1
100	7.7	17.2	19.4
110	9.5	17.4	19.5
120	12	17.5	19.3
130	13.6	17.5	19.1
140	14.3	17.6	18.8
150	14.5	17.4	18.9
160	15	17.3	18.9

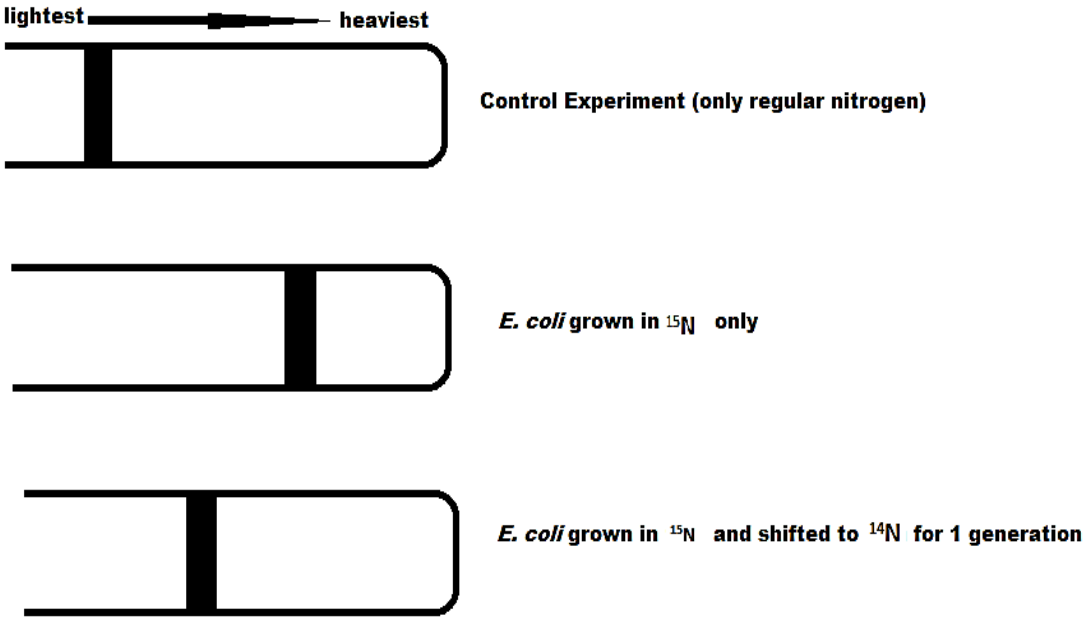
[14 marks]

QUESTION 6

a. Label each of the numbered ends of the diagram with either 5' or 3' (b & c) and indicate which strand is a leading strand and which strand is a lagging strand for the replication fork (redraw on plain paper given). **[4 marks]**



b. One of the key experiments that elucidated the mechanism of DNA replication was by Mathew Meselson and Franklin Stahl in 1958. They used *E. coli* to demonstrate that replication occurred semi-conservatively. They grew *E. coli* in nutrient broth that contained ^{15}N, which is a heavy isotope of nitrogen, for many generations (cell divisions) and then transferred the cells into broth containing normal nitrogen (^{14}N) for generation. They then isolated the DNA from these bacteria and found that ^{15}N had incorporated into the DNA (remember each of the bases have Nitrogen(s) in their structure). They purified the DNA using CsCl equilibrium density gradient centrifugation, which can separate different densities of DNA. The results are shown below (or next page):



Explain these results using your knowledge of replication. Predict what the bands would look like if the *E. coli* were left in ^{14}N for two generations. What would the bands look like in the 3rd generation in ^{14}N? [**9 marks]**

c. List the main similarities and major differences between bacterial and eukaryotic DNA replication. [**7 marks]**

END OF EXAMINATION