The University of Zambia

School of Health Sciences

2017/18 University Final Examinations

BSc Biomedical Sciences

Third Year

Molecular Biology - BMS 3225

Monday, 1st October, 2018 **09:00-12:00**

Instructions

1. This paper consists of **eight (8)** questions. You should answer **ALL** the four questions from Section A and **any three (3)** questions from Section B. This paper weighs 60% of the final examination score.

2. Each question must be answered in a **SEPARATE** answer booklet. Ask for additional booklets, if required. All questions in Section A carry 10 Marks each and All questions in section B carry 20 marks each.

3. It is **ESSENTIAL** that you indicate your student number on the cover page and on each sheet of paper. The number of each question answered and the Section where the question came from must also be recorded on the cover page.

4. Complete answer booklet should be handed in; all tied together, and will be collected BEFORE you leave your seat.

5. TIME ALLOWED: **Three (3) hours**

SECTION A

Instructions: Answer ALL questions. Each question carries 10 Marks

1. Complete the following table using the codon table: Label the 5' and 3' ends of DNA and RNA and the amino and carboxyl ends of the protein. Assume it is read left to right and the columns represent transcriptional and translational alignments **[10 Marks]**

DNA double helix	c	G	T	A	G	G	G	C	A	A	C	T
	G	C	A	T	C	C	C	G	T	t	g	a
mRNA	G	c	a	U	G	G	C	G	U	u	G	A
tRNA anticodon	C	G	U	A	C	C	g	c	a	A	C	U
Amino acid	Alanine			Trp			Arginine			STOP		

GENETIC CODE

	U	C	A	G
U	UUU Phenylalanine UUC Phenylalanine UUA Leucine UUG Leucine	UCU Serine UCC Serine UCA Serine UCG Serine	UAU Tyrosine UAC Tyrosine UAA Stop UAG Stop	UGU Cysteine UGC Cysteine UGA Stop UGG Tryptophan
C	CUU Leucine CUC Leucine CUA Leucine CUG Leucine	CCU Proline CCC Proline CCA Proline CCG Proline	CAU Histidine CAC Histidine CAA Glutamine CAG Glutamine	CGU Arginine CGC Arginine CGA Arginine CGG Arginine
A	AUU Isoleucine AUC Isoleucine AUA Isoleucine AUG Methionine/Start	ACU Threonine ACC Threonine ACA Threonine ACG Threonine	AAU Asparagine AAC Asparagine AAA Lysine AAG Lysine	AGU Serine AGC Serine AGA Arginine AGG Arginine
G	GUU Valine GUC Valine GUA Valine GUG Valine	GCU Alanine GCC Alanine GCA Alanine GCG Alanine	GAU Aspartate GAC Aspartate GAA Glutamate GAG Glutamate	GGU Glycine GGC Glycine GGA Glycine GGG Glycine

2. You are tasked to amplify the *Mycobacteria* heat-shock protein 65 gene (*hsp65*). The primer sequences are as follows:

Name of Primer	Primer Sequence	Amplicon size
Tb 11	5'-ACC AAC GAT GGT GTG TCC AT-3'	441bp
Tb 12	5'-CTT GTC GAA CCG CAT ACC CT-3'	

a) Calculate the melting temperature (T_m) of this primer? **[2 Marks]** $Tm = 2(A+T) + 4(G+C)$

b) What determines the choice of annealing temperature in PCR? Why is this so important? **[2 Marks]** number G+C regions and primer length.

c) Discuss what you think might happen if the task was repeated with an annealing temperature of:

i. 80°C : should be avoided because of the potential for secondary annealing
ii. 40°C : allows ~~most~~ mismatch

[4 marks]

d) Explain why *Taq* DNA polymerase is used in PCR rather than *E. coli* DNA polymerase? **[2 Marks]** because it can withstand higher temperatures because the temp used in PCR is 72°C

3. a). How would you prepare 3 litres of 1X TAE buffer from a 20X stock buffer? **Show your calculations [4 Marks]**

b). Briefly explain how you would prepare a 2% Agarose gel using part of your 1 X TAE buffer you prepared in question 3(a) **[3 Marks].**

c). Explain why Tris Borate EDTA is used in Agarose gel electrophoresis **[3 Marks]**

4. A strain of living *Streptococcus pneumoniae* which cannot make a capsule is injected into mice and has no adverse effect. This strain is then mixed with a culture of heat-killed *Streptococcus pneumoniae* which when alive was able to make a capsule and kill mice. After a period of time, this mixture is injected into mice and kills them. In terms of genetic recombination, describe what might account for this. **[10 marks]**

Section B

Instructions: Answer any three (3) out of the four questions on separate answer booklets. Each question carries 20 Marks

1. Write short notes on:
   a) Genome annotation **[10 Marks]**

   b) Phylogenetic tree and information that can be obtained from it **[10 Marks]**

2. You have discovered a novel organism that thrives in the ocean depths in the hostile environment of hydrothermal vents. In characterizing its replication, you are astounded that it replicates both strands continuously using two DNA polymerases: one that synthesizes DNA in the usual 5'- to -3' direction and a second that synthesizes DNA in the 3'- to -5' direction. Both polymerases use the standard nucleotide 5'-triphosphates for addition of nucleotides to the growing DNA chains. You are surprised to find that both newly synthesized DNA strands are made with the same high degree of fidelity that characterizes DNA synthesis in *E. coli*.
   a) Briefly describe the four (4) processes that contribute to the high fidelity of DNA replication in *E. coli* **[8 marks]**
   b) Explain why it is surprising that both strands in this novel organism are replicated with high fidelity **[2 marks]**
   c) Suggest at least two (2) ways by which high fidelity might be accomplished. If you need to invent additional enzymes to accomplish a specific task, describe their activities **[2 marks]**
   d) With the help of a diagram, briefly describe how DNA replication is terminated in *E. coli* **[5 marks]**
   e) How is the DNA end-replication problem solved in eukaryotes? **[3 marks]**

3. Define Competency. How is bacteria made to be competent? Describe two methods for selection of recombinant bacterial clones **[20 Marks]**

4. In tabular form and in great but organised detail, compare the structures of eukaryotic and prokaryotic genomes**[20 Marks]**