UNIVERSITY OF ESWATINI
FINAL EXAMINATION PAPER: MAY 2019

TITLE OF PAPER: INTRODUCTION TO MOLECULAR BIOLOGY

COURSE CODE: BIO 202

TIME ALLOWED: THREE HOURS

INSTRUCTIONS: 1. ANSWER SECTION A (COMPULSORY) AND ANY THREE OTHER QUESTIONS.

2. ANSWER A TOTAL OF 3 (THREE) QUESTIONS
3. EACH QUESTION COUNTS TWENTY FIVE (25) MARKS
4. ILLUSTRATE YOUR ANSWERS WITH CLEARLY LABELLED DIAGRAMS WHERE APPROPRIATE

SPECIAL REQUIREMENTS:

1. CANDIDATES MAY USE CALCULATORS

THIS PAPER SHOULD NOT BE OPENED UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATORS

[PLEASE TURN OVER]

SECTION A [Compulsory]

Question 1A, (Multiple Choice, Total Marks = 20]

1. The DNA in a eukaryotic chromosome is best described as:
   A. A single circular double-helical molecule.
   B. A single linear double-helical molecule.
   C. A single linear single-stranded molecule.
   D. Multiple linear double-helical molecules.

2. Which of the following is NOT a nucleoside?
   A. Adenosine
   B. Cytidine
   C. Cytosine
   D. Guanosine

3. Nucleotides are linked together via:
   A. H-bonds
   B. 3',5'-phosphoester bonds
   C. 3',5'-phosphodiester bonds
   D. N1-glycosidic bonds

4. Which of the following is not a constituent of deoxyribonucleotides?
   A. phosphate moieties
   B. deoxyribose
   C. ribose sugar
   D. Nitrogenous base

5. An enzyme that breaks DNA, dispels the tension, and reseals the strand ahead of a DNA replication growing fork is called a (n)
   A. Topoisomerase.
   B. DNA polymerase.
   C. Phosphodiesterase.
   D. Aminoacyl-tRNA synthetase.

6. An Okazaki fragment is a:
   A. Fragment of DNA resulting from endonuclease action.
   B. Fragment of RNA that is a subunit of the 30S ribosome.
   C. Piece of DNA that is synthesized in the $3' \rightarrow 5'$ direction.
   D. Segment of DNA that is an intermediate in the synthesis of the lagging strand.
   E. Segment of mRNA synthesized by RNA polymerase.

7. Which one of the following statements about enzymes that interact with DNA is *true*?
   A. *E. coli* DNA polymerase I is unusual in that it possesses only a $5' \rightarrow 3'$ exonucleolytic activity.
   B. Endonucleases degrade circular but not linear DNA molecules.
   C. Exonucleases degrade DNA at a free end.
   D. Many DNA polymerases have a proofreading $5' \rightarrow 3'$ exonuclease.
   E. Primases synthesize a short stretch of DNA to prime further synthesis.

8. *E. coli* DNA polymerase III:
   A. Can initiate replication without a primer.
   B. Is efficient at nick translation.
   C. Is the principal and processive DNA polymerase in chromosomal DNA replication.
   D. Represents over 90% of the DNA polymerase activity in *E. coli* cells.
   E. Requires a free 5′-hydroxyl group as a primer.

9. Which of the following statements *correctly* describes promoters in *E. coli*?
   A. A promoter may be present on either side of a gene or in the middle of it.
   B. All promoters have the same sequence that is recognized by RNA polymerase holoenzyme.
   C. Every promoter has a different sequence, with little or no resemblance to other promoters.
   D. Many promoters are similar and resemble a consensus sequence, which has the highest affinity for RNA polymerase holoenzyme.
   E. Promoters are not essential for gene transcription, but can increase its expressions rate by two- to three-fold.

10. The operator region of a gene can normally be bound by:
   A. Attenuator.
   B. Inducer.
   C. mRNA.
   D. Repressor.

11. Which of the following factors recognizes the UAG, UAA, and UGA codons?
   A. RNA polymerase
   B. DNA polymerase
   C. Termination factors
   D. Elongation factors

12. Which codon serves as the start codon in mRNA for translation?
   A. AGU
   B. AUG
   C. UGA
   D. UGG

13. Which of the following is a protein that is involved in RNA translation?
   A. Topoisomerase
   B. Ribosomal RNA
   C. RNA polymerase
   D. Aminoacyl-tRNA synthetase

14. Constitutive expression of the lactose operon in *E. coli* may stimulated by:
   A. A mutation in the repressor gene that strengthens the affinity of the repressor for the operator.
   B. A mutation in the repressor gene that weakens the affinity of the repressor for the operator.
   C. A mutation in the repressor gene that weakens the affinity of the repressor for the inducer.
   D. Binding of the repressor to the operator.
   E. The presence of glucose in the growth medium.

15. Which of the following statements about regulation of the *lac* operon is *true*?
    A. Glucose in the growth medium decreases the inducibility by lactose.
    B. Glucose in the growth medium does not affect the inducibility by lactose.
    C. Glucose in the growth medium increases the inducibility by lactose.
    D. Its expression is regulated mainly at the level of translation.
    E. The *lac* operon is fully induced whenever lactose is present.

16. The binding of CAP (cAMP activator protein of *E. coli*) to DNA in the *lac* operon:
    A. Assists RNA polymerase binding to the *lac* promoter.
    B. Is inhibited by a high level of cAMP.
    C. Occurs in the *lac* repressor region.
    D. Occurs only when glucose is present in the growth medium.
    E. Prevents the repressor from binding to the *lac* operator.

17. When there is neither glucose nor lactose in the growth medium, What is the effect *lac* operon
    A. CRP protein binds to the *lac* operator.
    B. CRP protein displaces the Lac repressor from the *lac* promoter.
    C. The repressor is bound to the *lac* operator.
    D. RNA polymerase binds the *lac* promoter and transcribes the *lac* operon.
    E. The operon is fully induced.

18. Carbamoyl phosphate synthetase II (CPS-II) is:
    A. Activated by PRPP
    B. Inhibited by UMP
    C. Activated by ATP
    D. The key committed step in the formation of carbamoyl~phosphate
    E. All of the above are correct

19. What is the correct sequence of appearance of intermediates in the degradation of adenosine?
    A. Adenosine --> hypoxanthine -->xanthine --> inosine --> uric acid
    B. Adenosine --> inosine --> hypoxanthine --> xanthine --> uric acid
    C. Adenosine --> xanthine --> hypoxanthine --> inosine --> uric acid
    D. None of the above are correct

20. The most updated definition of a gene is a segment of genetic material that:
    A. Codes for one polypeptide.
    B. Codes for one polypeptide or RNA product.
    C. Determines one phenotype.
    D. Determines one trait.
    E. That codes for one protein.

Question 1B (Short Answer Questions, Total Marks = 30)

21. Briefly define the following: [10 marks]
    i. Polycistronic RNA
    ii. Operon
    iii. Constitutive gene expression
    iv. Repression of gene expression
    v. Inducible gene

22. Draw a labelled schematic representation of a typical Eukaryotic gene. [5 marks]

23. List four ways by which a primary RNA transcript can be processed in eukaryotes. [4 marks]

24. Determine the sequence of mRNA from the following peptide (Refer to Fig. 1) [3 marks]

25. State and explain the four major steps involved in extracting and purifying DNA from a cell. [8 marks]

Question 2

a) Describe the steps involved in de-novo purine synthesis [10 marks]

b) Briefly describe transcription in the context of chromatin. [5 marks]

c) Using diagrams, illustrate the process of protein synthesis (translation) [10 marks]

Question 3

List the different proteins/enzymes involved in DNA replication and describe their roles in this process. [25 marks]

Question 4

Explain the regulation of the *lac operon* highlighting the role of repressor protein and when this protein is active and/or inactive. [25 marks]

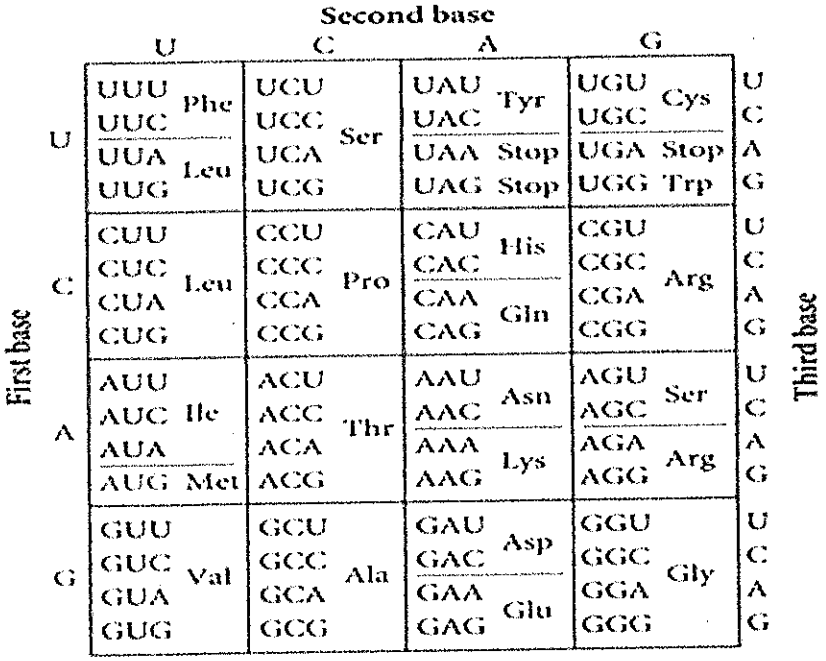

Figure 1: Genetic code

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Place an 'X' against the most appropriate answer. For instance if the answer for Question 99 is D, the answer answer appear as shown below.

Question	A	B	C	D	E
99				X	

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