

STUDENT ID:.....



UNIVERSITY OF GHANA
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BSC ENGINEERING
DEPARTMENT OF BIOMEDICAL ENGINEERING
FIRST SEMESTER EXAMINATIONS: 2015/ 2016
BMEN 403: CELL AND MOLECULAR BIOLOGY (2 CREDITS)

INSTRUCTION:

**ANSWER ALL QUESTIONS IN SECTION A ON THE QUESTION PAPER.
SECTION B AND SECTION C IN THE ANSWER BOOKLET**

TIME ALLOWED: 2.5 HOURS

*SECTION A: MULTIPLE CHOICE QUESTIONS. CIRCLE THE CORRECT ANSWER
ON THE QUESTION PAPER. 1 POINT FOR EACH QUESTION ANSWERED
CORRECTLY. 20 POINTS IN TOTAL FOR THIS SECTION.*

1. The most prominent examples of RNA genes are except:
(A) tRNA and rRNA
(B) rRNA and mRNA
(C) mRNA and tRNA
(D) sRNA and tRNA
(E) sRNA and mRNA
2. The following are features of DNA replication EXCEPT
(A) Semi-Conservative
(B) Unidirection
(C) Chain growth in the 5' \Rightarrow 3' direction
(D) Semidiscontinuous
(E) Primase cutting
3. Which of the following does not have introns?
(A) DNA
(B) Non-processed pseudogenes
(C) Processed mRNA
(D) Primary RNA transcript
(E) reading frame

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4. Which out of the following is an example of post translational modification?
(A) Splicing
(B) Subunit aggregation
(C) Base modification
(D) tRNA sliding
(E) Base witching
5. A culture started with 4 cells and ended with 128 cells. How many generations did the cells go through?
(A) 64
(B) 32
(C) 6
(D) 5
(E) 4
6. In Protein expression, transcription and translation occur. What happens during transcription?
(A) nucleotides are polymerized by DNA polymerase
(B) initiation occurs at a site recognized by the sigma factor
(C) only single gene-sized mRNA molecules are synthesized
(D) both DNA strands of a single gene are used as templates simultaneously
(E) thymine in RNA pairs with adenine in DNA
7. The promoter regions in DNA are nucleotide sequences that:
(A) are involved in the initiation of transcription
(B) are involved in transcription termination
(C) contain the code for 1mRNA molecule
(D) are important to the translation process
(E) all of the above
8. Where exactly can you locate the codon?
(A) DNA
(B) rRNA
(C) tRNA
(D) mRNA
(E) protein
9. What is the anticodon that recognizes CGA?
(A) UGC
(B) CGA
(C) GCU
(D) GCT
(E) GCA

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10. Any process that results in the integration of a new gene into a vector is called:
- (A) genetic recombination
 - (B) fusion
 - (C) genetic fission
 - (D) allelotyping
 - (E) genetic addition
11. An enzyme that recognizes a specific (palindromic) sequence and cuts within a DNA molecule is called a(n):
- (A) exonuclease
 - (B) methylase
 - (C) modification enzyme
 - (D) restriction endonuclease
 - (E) cutting enzyme
12. The amount of a specific DNA sequence can be increased more than 10^6 fold by using which of the following chemical reactions?
- (A) restriction endonuclease reaction
 - (B) ligation reaction
 - (C) polymerase chain reaction
 - (D) reverse translation
 - (E) reverse transcriptase reaction
13. Checkpoint controls prevent DNA replication or
- (A) Protein synthesis
 - (B) Mitosis of damaged cells
 - (C) RNA processing
 - (D) DNA-RNA complex formation
 - (E) Duplex formation
14. Which of the following is correct?
- (A) A forms 2 hydrogen bonds with G; T forms 3 hydrogen bonds with C
 - (B) A forms 3 hydrogen bonds with T; G forms 2 hydrogen bonds with C
 - (C) A forms 2 covalent bonds with T; G forms 3 covalent bonds with C
 - (D) A forms 2 hydrogen bonds with T; G forms 3 hydrogen bonds with C
 - (E) none of the above
15. The amount of adenine is always equal to the amount of _____ in DNA.
- (A) Cytosine
 - (B) Uralic
 - (C) Guanine
 - (D) Thymine
 - (E) ATP

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16. Which of the classes of RNA molecules is linked with proteins in forming the large and small subunits of protein synthesis structure?
(A) ribosomal RNA
(B) transfer RNA
(C) messenger RNA
(D) primary mRNA transcript
(E) siRNA
17. Rhodopsin, Beta-adrenergic receptors, and cannabinoid receptors share which of the following features?
(A) Each causes an inhibitory intracellular response.
(B) Each activates a tyrosine kinase cascade.
(C) Each is composed of a dimer.
(D) Each functions through a heterotrimeric G-protein.
(E) Each gates a cation channel.
18. Two functions of the rough endoplasmic reticulum are to
(A) detoxify and transport drugs
(B) modify and activate hormones
(C) synthesize and transport enzymes
(D) join with and hydrolyze food vacuoles
(E) communicate with the nucleus
19. Inside which portion of a cell does translation take place?
(A) The endoplasmic reticulum
(B) The nucleus
(C) The cytosol
(D) The Golgi complex
(E) The cell membrane
20. What is the symbol for the amino acid Tryptophan?
(A) A
(B) G
(C) R
(D) I
(E) W

SECTION B: ANSWER ALL QUESTIONS IN THIS SECTION. 30 POINTS IN TOTAL FOR THIS SECTION.

1. List the hydrogen bond donors and acceptors available in the major and minor grooves of the DNA double helix. (5 pts)
2. What are the criteria for constructing a recombinant DNA? (5 pts)
3. How do you isolate a functional expressed protein from the recombinant DNA? (5 pts)
4. Draw the structure of the major class of phospholipid found in animal tissues.

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- 5. (a) State the major processes for protein expression. (5 pts)
- (b) State the major enzymes involved these processes. (2 pts)
- 6. Name 4 things that you need to amplify a piece of DNA using PCR. (4 pts)

SECTION C: ANSWER ANY TWO QUESTIONS. 25 POINTS FOR EACH QUESTION.

(1) Please explain with diagrams the signaling in the following proteins:

(A) G-protein coupled receptors (15 pts)

(B) Tyrosine kinases (10 pts)

(2) A cell line expressing a G-protein coupled receptor was bought from a Company. The receptor can be activated by an endogenous ligand called **L** to cause tumor progression. The cells can also produce the corresponding G-proteins and adenylyl cyclase. There is a basal level of adenylyl cyclase activity that produces a baseline cAMP concentration. Your project is to design series of ligands to compete with **L** for the binding site in this receptor to avoid the cancer signaling pathway.

(A) Draw the signaling pathway of the GPCR when **L** binds. (8 pts)

(B) What happens if the α subunit of the G protein is mutated? (4 pts)

(C) Explain whether the mutation will increase or decrease the intracellular levels of GDP upon ligand addition. (2 pts)

(D) Conformational Change is responsible for GPCRs activation. Explain how this happens. (11 pts)

(3) The $\text{Na}^+\text{-K}^+$ Pump is driven by the transient addition of a phosphate group. Draw a diagram to describe how the pump couples one reaction to the other in moving Na^+ and K^+ in and out of the cell. (25 pts)

THE END OF THE EXAMINATION