UNIVERSITY OF GHANA

FIRST SEMESTER EXAMINATIONS: 2014/ 2015
LEVEL 400: BACHELOR OF SCIENCE IN ENGINEERING
BMEN 403: CELL AND MOLECULAR BIOLOGY
TIME ALLOWED: 3 HOURS (3 CREDITS)

Section A: Multiple Choice Questions. Answer ALL. 1 POINT for each question answered correctly. 20 points in total for this section.

1. The necessary ingredients for DNA synthesis can be mixed together in a test tube. The DNA polymerase is from *Thermus aquaticus* and the template is from a human cell. The DNA synthesized would be most similar to:
   (A) human DNA
   (B) *T. aquaticus* DNA
   (C) a mixture of *T. aquaticus* and human DNA
   (D) human RNA
   (E) *T. aquaticus* RNA

2. Which of the following is best to sterilize heat labile (heat unstable) solution?
   (A) dry heat
   (B) autoclave
   (C) membrane filtration
   (D) pasteurization
   (E) none of the above

3. Which of the following is bactericidal (lethal to bacteria)?
   (A) membrane filtration
   (B) ionizing radiation
   (C) deep freezing
   (D) all of the above
   (E) visible radiation

4. A culture medium on which only gram positive organisms grow and a yellow halo surrounds *Staphylococcus aureus* colonies is called a:
   (A) selective medium
   (B) differential medium
   (C) enrichment culture
   (D) a and b
   (E) b and c

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

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

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) none of the above

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. Assume you inoculated 100 cells into 100 ml of nutrient broth and 100 cells in 200 ml of nutrient broth. After incubation for 24 hrs the cultures have entered stationary phase. You should have:
    (A) more cells per ml in the 100 ml
    (B) more cells per ml in the 200 ml
    (C) the same number of cells per ml in each
    (D) very difficult to determine
    (E) none of the above

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: Please 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. (5 pts)
5. (a) State the major processes for protein expression. (2 pts)
   (b) State the major enzymes involve the two processes (4 pts)
6. The ebola virus is so much more deadly than the malaria parasite. Why? (4 pts)

Section C: Please Answer TWO Questions. 25 pts for each question.

(1) Please describe the purpose and methods employed in the following techniques:

(A) Southern Blot (7 pts)

(B) Northern Blot (6 pts)

(C) Western Blot (7 pts)
(D) PCR (5 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 **BOLT** 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 BOLT for the binding site in this receptor to avoid the cancer signaling pathway.
(A) Draw the signaling pathway of the GPCR when BOLT binds. (8 pts)
(B) Is it necessary to design mutations in the GPCR? Explain. (4 pts)
(C) Explain whether the mutation will increase or decrease the intracellular levels of cAMP upon ligand addition. (2 pts)
(D) What is meant by the term a "toggle switch"? (2 pts)
(E) Use the concept of toggle switch and helical bundle to explain receptor activation. (11 pts).

(3) (A) Give three words that can be used to define a virus. (3 pts)
(B) How will you describe the morphology of a virion? (8 pts)
(C) The malaria parasite enters the red blood cells (RBCs) through Complementary receptor 1. You are asked to design a molecule that can compete with the parasite for RBC entry. What are some of the factors you need to consider to design the molecule? (14 pts)

THE END OF THE EXAMINATION