

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

A. Multiple choice (choose one answer only)

1. The sequence of a piece of DNA reads as 5'- GAATTCC - 3', what is the complementary DNA sequence to this? (2 %)
 - A) 5' - GGAAUUC - 3'
 - B) 5' - GCAAUTC - 3'
 - C) 5' - GGAATTC - 3'
 - D) 3' - CTTAAGG - 5'
 - E) none of the above
2. How many hydrogen bonds form between G and C in standard Watson-Crick base pair interactions? (2 %)
 - A) 0
 - B) 1
 - C) 2
 - D) 3
 - E) 4
3. The nucleosome is composed of which of the following? (2 %)
 - A) a histone octamer & approximately 150 bp of DNA
 - B) transcription factors
 - C) DNA and RNA
 - D) TFIID and TFIIA
 - E) Reverse transcriptase and DNA Pol I
4. The absorption maximum of double-stranded DNA is at: (2 %)
 - A) 280 nm
 - B) 360 nm
 - C) 260 nm
 - D) 210 nm
 - E) 520 nm
5. A zinc finger: (2 %)
 - A) is a protein-protein interaction motif
 - B) a motif in proteins that binds DNA
 - C) is found in DNA pol I
 - D) binds a zinc atom
 - E) both B & D

B. Essay questions

6. Explain and illustrate the stepwise mechanisms of the three major types of DNA excision repair in *E. coli* and **mammals: base excision repair, nucleotide excision repair and mismatch repair**. List the major DNA repair factors involved in each pathway and provide the function (e.g., enzymatic activity) of each of these factors. (15%)
7. Describe the role of intron and exon in the alternative splicing of RNA transcripts, and how alternative splicing affects the generation of mature proteins and their potential functions. Give an example of a gene of your interest. (15%)
8. You have purified a protein called “IMM” from patients with Alzheimer’s disease. This protein is 100 kDa, and has 2 isoforms of 60 and 30 kDa, respectively. This protein appears to be involved in Alzheimer’s disease. Describe step-by-step regarding how you will clone the gene for this protein and determine the protein functions both *in vitro* and *in vivo*. You may use illustrations to address your points. (20%)
9. Please describe the regulation of the *lac* operon in bacteria (10%).
10. Engineered CRISPR systems have been developed to achieve a variety of genomic modifications such as gene knockout, gene editing, and modification of gene expression, in genomes of different organisms. Please answer the following questions regarding this system(10%).
- What is the function of the original CRISPR/Cas 9 system in bacteria?
 - In addition to the Cas 9 nuclease, what is another component in the two essential components in this system?
 - What are the cellular responses if the system cleaves double-stranded DNA?
11. 簡答題(20%, 2 points/each question)
- 1) What is euchromatin?
 - 2) What is the site where most of DNA methylation is found in a eukaryotic genome?
 - 3) What is telomere?
 - 4) What is the total number of the codons used in the genetic code to encode 20 kinds of amino acids?
 - 5) What is siRNA?
 - 6) What is the difference between the first amino acid in a newly synthesized polypeptide in bacteria and in human cells?
 - 7) What is TATA box?
 - 8) What is the capping nucleotide at the beginning of a eukaryotic mRNA?
 - 9) What is the function of the Shine-Dalgarno sequence in bacteria?
 - 10) What kind of DNA damage is usually caused by UV?