

※ 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。

一、單選題 (共 20 分，每題 2 分)

1. Which of the following enzymes is NOT directly involved in DNA replication?

- (A) DNA ligase
- (B) Helicase
- (C) Topoisomerase
- (D) DNA polymerase
- (E) Endopeptidase

2. What is the signal for RNA polymerase to stop transcription?

- (A) Stop codon
- (B) D loop
- (C) The 3'-end of DNA
- (D) Terminator
- (E) Enhancer

3. What is the function of bacterial sigma factor?

- (A) Help the assembly of ribosome
- (B) Help elongation of the polypeptide chain during translation
- (C) Help transcription elongation
- (D) Help initiation of transcription
- (E) Help initiation of translation

4. Which statement about prokaryotic ribosome is NOT correct?

- (A) The ribosome is mainly composed of r-proteins and rRNA.
- (B) The 50S subunit can bind initiation factors to initiate translation.
- (C) A site is where aminoacyl-tRNA enter the ribosome.
- (D) Deacylated tRNA leaves the ribosome via E site.
- (E) P site of the ribosome is occupied by peptidyl-tRNA.

5. What is the DNA strand on which DNA replication is discontinuous?

- (A) Major strand
- (B) Minor strand
- (C) Lagging strand
- (D) Leading strand
- (E) Okazaki fragments

6. Which of the following statements is TRUE?

- (A) Adenylate is one kind of nucleotides in RNA
- (B) Uracil is one kind of purines
- (C) Cytidine is one kind of purines
- (D) Deoxythymidylate is one kind of nucleosides in DNA
- (E) Guanosine is one kind of nucleotides in RNA

7. Which of the following statements is NOT true?

- (A) Native DNA is a double helix of complementary antiparallel strands
- (B) The A,T, G,C, A,U are the Watson-Crick base pairs
- (C) The A form of DNA structure is more compact than the B form of DNA
- (D) The Z form of DNA is a left-handed double helix
- (E) The doubled-stranded DNA has higher absorption at 260 nm than the single- stranded DNA

8. Which of the following statements is TRUE?

- (A) The cluster of genes of a bacterial operon comprises multiple transcription units
- (B) Translation of a bacterial mRNA cannot begin before the synthesis of the mRNA is completed
- (C) UAU is a stop codon for translation of a mRNA in eukaryotes
- (D) DNA polymerase cannot unwind the strands of duplex DNA
- (E) The non-homologous end-joining repair system is a major repair mechanism for repairing double-strand breaks and rarely generates errors

9. Which of the following statements is NOT true?

- (A) During replication, adjacent Okazaki fragments are joined by DNA ligase
- (B) DNA replication generally occurs by a bidirectional mechanism
- (C) Most of the DNA in eukaryotes is synthesized by Pol  $\alpha$
- (D) Activity of MCM helicases initiates DNA replication at multiple origins in eukaryotes
- (E) DNA polymerases can introduce errors in replicating DNA

10. Which of the following statements is TRUE?

- (A) A gene is defined as the entire DNA sequence required for synthesis of a functional protein, but not for an RNA
- (B) In both invertebrates and vertebrates, rRNAs are encoded by a single copy of genes
- (C) Very few nonfunctional DNA sequences are present in vertebrates as compared to prokaryotes
- (D) Xist is a nonprotein-coding RNA, regulating X-chromosome inactivation
- (E) DNA transposons are only found in eukaryotes

## 二、簡答題 (共 20 分)

1. List the names of three excision-repair systems in eukaryotes (3%).
2. List three types of modification occurring at histone tails (3%).
3. List two other most important functional elements within a eukaryotic linear chromosome besides replication origins (2%).
4. Briefly define the functions of miRNAs (3%).
5. Briefly define the TATA box of a gene (4%).
6. What is the name for the sequence AAUAAA, found in most protein-coding pre-mRNA? What is the role for this sequence? (5%)

三、問答題 (共 60 分)

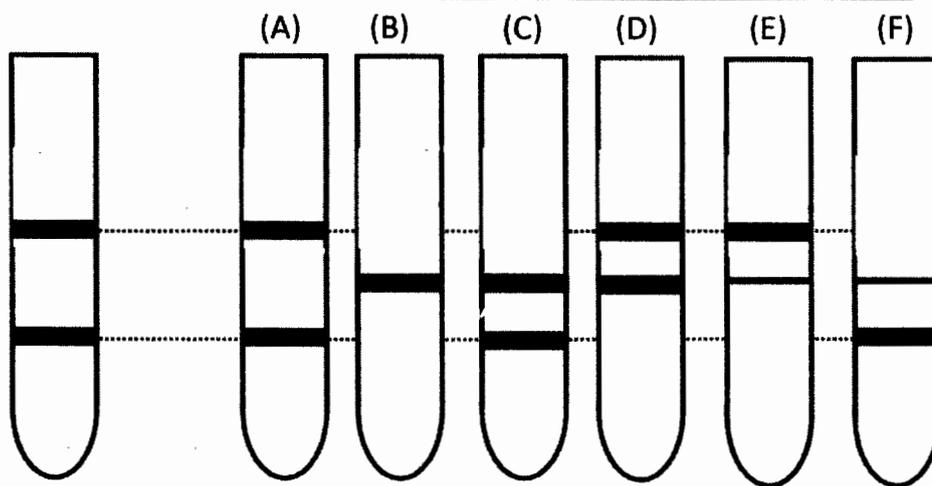
- Transformation, transduction, conjugation, and transposition are utilized by Prokaryotic cells for genetic exchange. Please describe the four distinct mechanisms (12%).
- Meselson and Stahl (1958) cultured *E. coli* in media containing  $^{14}\text{N}$  (nitrogen) or  $^{15}\text{N}$  (nitrogen) to label the bacterial DNA. The DNA from the bacteria grown on the  $^{14}\text{N}$  and  $^{15}\text{N}$  media were mixed, and applied to CsCl density gradient centrifugation. **Figure 1** shows the result; two DNA bands were observed in the centrifuge tube. Then, they transferred the bacteria originally cultured in a  $^{15}\text{N}$  medium to a  $^{14}\text{N}$  medium and allowed the bacteria to replicate in the new medium.

Questions:

- After one round of replication in the  $^{14}\text{N}$  medium, bacterial DNA was extracted and analyzed with CsCl density gradient centrifugation. Which tube shown in **Figure 2** is the result obtained by Meselson and Stahl? Please briefly explain why (3%).

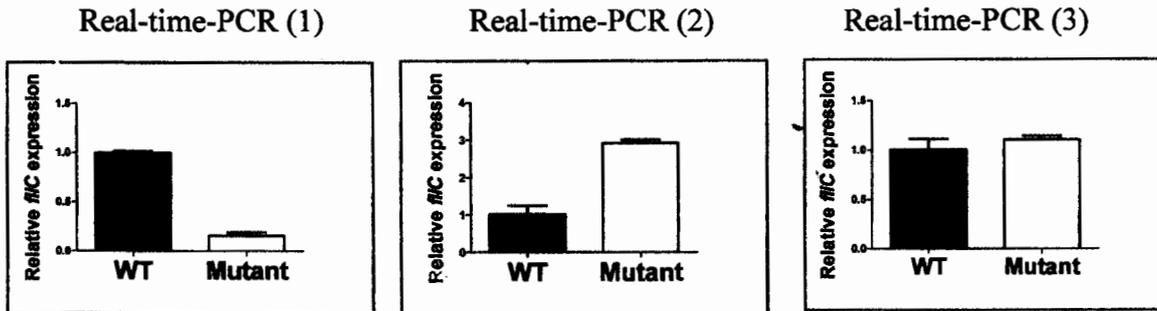
Figure 1

Figure 2

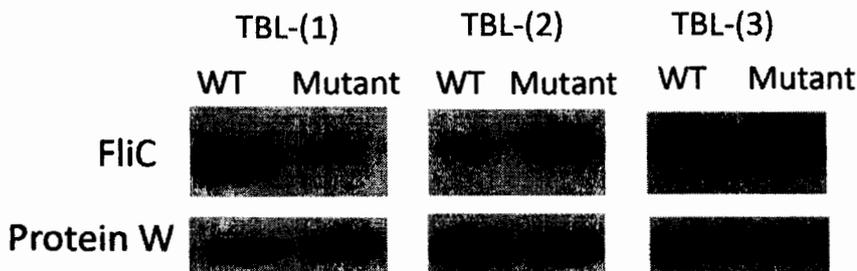


- After two rounds of replication in the  $^{14}\text{N}$  medium, bacterial DNA was extracted and analyzed with CsCl density gradient centrifugation. Which tube shown in Figure 2 is the result obtained by Meselson and Stahl? Please briefly explain why (3%).
- Flagella are bacterial structures located on the cell wall of *E. coli*. This structure is mainly composed of the FliC protein that is encoded by the *fliC* gene. Flagella are responsible for the mobility of the bacteria. A scientist found that the *X* gene mutant of *E. coli* showed decreased mobility. He started to ask how *X* gene affected the mobility by analyzing the wild-type (WT) *E. coli* and its *X* gene mutant. The following figures are the potential results of Real-time PCR analyses of *fliC* expression, Western blot analyses of total bacterial lysate (TBL), and Western blot analyses of the cell wall fraction (CWF) of bacteria. Protein W is a cell wall protein whose expression level is stable and not affected by the *X* gene.

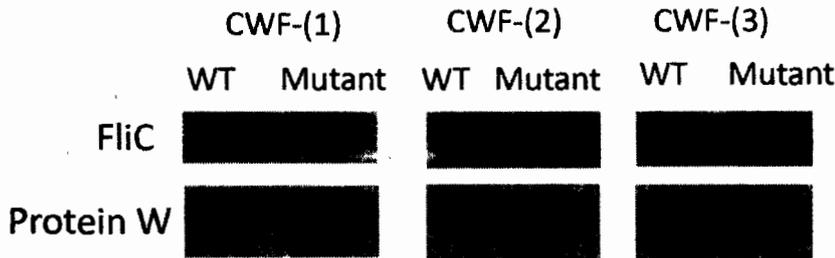
Real-time PCR results:



Results of Western blot of total bacterial lysate (TBL):



Results of Western blot of the cell wall fraction (CWF):



Question:

- (A) If the results are Real-time-PCR (1), TBL-(1), and CWF-(1), please try to explain how X gene affects bacterial mobility (3%).
  - (B) If the results are Real-time-PCR (3), TBL-(1), and CWF-(1), please try to explain how X gene affects bacterial mobility (3%).
  - (C) If the results are Real-time-PCR (2), TBL-(2), and CWF-(1), please try to explain how X gene affects bacterial mobility (3%).
  - (D) What is the purpose for showing protein W in the Western blot analyses? (3%)
4. Methylation can occur at the CpG island of some genes in vertebrates, and hypermethylation was often found in some genes of cancer tissues. Define the CpG island and methylation at CpG island. Define this type of methylation regulation in gene expression, its effect on gene expression, and give an example to describe its role in cancer (10%).
  5. If there are only 20 amino acids used in protein synthesis, what is the known **expected** number of tRNAs required for translation to occur? Explain the reasons. However, 50-100 kinds of tRNAs are found in animal

cells. Why this excess number of tRNAs is present compared to amino acids? (10%)

6. What is the specialized structure at the ends of eukaryotic chromosomes? Why is this structure required for the chromosome? What are the enzymes involved in replicating this part of DNA? (10%)