

系所組別：分子醫學研究所

考試科目：分子生物學

考試日期：0224，節次：2

※ 考生請注意：本試題不可使用計算機

請勿在本試題紙上作答，否則不予計分

## 一、選擇題 (45 分，每題 3 分，單選)

1. 5'-TCGTAAGTC-3' is the template strand sequence of a gene fragment. This gene fragment will be transcribed as:

- (a) 5'-GACUUACGA-3'
- (b) 5'-UCGUAAGUC-3'
- (c) 5'-TCGTAAGTC-3'
- (d) 5'-AGCAUUCAG-3'
- (e) 5'-CUGAAUGCU-3'

2. How many hydrogen bonds are (is) present to hold an adenine-thymine base pair in DNA?

- (a) 1
- (b) 2
- (c) 3
- (d) 4
- (E) 5

3. Which of the following mRNA sequence is most likely to be an intrinsic terminator in *E. coli*?

- (a) 5'-GCCCCGCCGG-----CCGGCGGGCAAAAAAAAA-3'
- (b) 5'-GUGAUUAAA-----UUUAAUCACAUUUUUU-3'
- (c) 5'-GCCCCGCCGG-----UUUAAUCACAAAAAAAA-3'
- (d) 5'-GUGAUUAAA-----CCGGCGGGCAUUUUUU-3'
- (e) 5'-GCCCCGCCGG-----CCGGCGGGCAUUUUUU-3'

4. Which of the following statement regarding Taq DNA polymerase is correct?

- (a) The PCR product generated by this polymerase usually has one extra T at 5'-end
- (b) The PCR product generated by this polymerase usually has one extra C at 5'-end
- (c) The PCR product generated by this polymerase usually has one extra A at 3'-end
- (d) The PCR product generated by this polymerase usually has one extra T at 3'-end
- (e) The PCR product generated by this polymerase usually has one extra G at 5'-end

5. The prokaryotic core RNA polymerase doesn't contain which component(s)?

- (a) The  $\alpha$  (alpha) subunit
- (b) The  $\beta$  (beta) subunit
- (c) The  $\beta'$  (beta') subunit
- (d) The  $\sigma$  (sigma) subunit
- (e) The  $\beta$  and  $\beta'$  subunits

(背面仍有題目，請繼續作答)

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6. Which of the following assay can be used to investigate protein-protein interaction?
- (a) Electrophoresis mobility shift assay (EMSA)
  - (b) Chromatin immunoprecipitation (ChIP) assay
  - (c) Denatured gradient gel electrophoresis (DGGE) assay
  - (d) Yeast two-hybrid assay
  - (e) RNase A protection assay
7. Which statement regarding the initiation of bacterial protein synthesis is NOT correct?
- (a) The 30S ribosomal subunit can recognize the Shine-Dalgarno sequence during initiation
  - (b) IF-3 is required for 30S subunits to bind specifically to initiation sites in mRNA
  - (c) The presence of IF-3 facilitate the binding of 30S subunits to 50S subunits to form 70S ribosomes
  - (d) IF-2 binds the initiator tRNA (fMet-tRNA<sub>f</sub>) and allows it to enter the 30S subunit
  - (e) IF-1 binds to the A site of ribosome to prevent the entering of aminoacyl-tRNA
8. The melting temperature of DNA is the temperature at which:
- (a) DNA denatures to become single strands
  - (b) DNA starts degrading
  - (c) RNA polymerase binds to DNA
  - (d) DNA binds to core histones
  - (e) DNA polymerase starts its function
9. Which of the following statement regarding bacterial transcription is NOT correct?
- (a) Bacterial transcription can be divided into three major steps: initiation, elongation, and termination.
  - (b) During elongation, the RNA chain is extended in the 5'→3' direction.
  - (c) Bacterial translation can start before the termination of transcription.
  - (d) Mutations in the -35 sequence of promoters usually affect initial binding of RNA polymerases
  - (e) Bacterial transcription starts from the start codon of open reading frames.
10. Which statement is correct regarding viral infection and immunity?
- (a) Antigenic drift and antigenic shift are examples of hepatitis C virus to escape the detection of host neutralizing antibodies.
  - (b) Lentiviruses (e.g. HIV) infect both dividing and non-dividing cells.
  - (c) Type I IFNs can activate the cytotoxic activity of NK cells and has very trivial roles in stimulating T cell IFN- $\gamma$  responses.
  - (d) Intracellular antigens are mostly presented by MHC- I surface molecules; therefore, viral antigens are rarely presented by MHC-I.

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(e) The IRES (Internal Ribosomal Entry Site) is a critical RNA element responsible for the RNA-dependent RNA transcription of most RNA viruses.

11. Philadelphia chromosome is a characteristic feature of chronic myelogenous leukemia. The abnormal chromosome is a result of translocation between which 2 chromosomes?

- (a) t(1;19)
- (b) t(4;11)
- (c) t(8;21)
- (d) t(9;22)
- (e) t(15;17)

12. The Philadelphia chromosome gives rise to an abnormal fusion protein with oncogenic activities. Which of the following statements about the fusion protein is correct?

- (a) The N-terminal domain of the fusion protein contains tyrosine kinase activity derived from the *abl* gene.
- (b) The N-terminal domain of the fusion protein is derived from the *bcr* gene which permits the tetramerization of the protein.
- (c) The C-terminal domain of the fusion protein contains serine/threonine protein kinase activity derived from *abl* gene.
- (d) The C-terminal domain of the fusion protein is derived from the *bcr* gene which permits the dimerization of the protein.

13. The translocation related to the Philadelphia chromosome can be detected by various methods EXCEPT

- (a) Array CGH (array comparative genomic hybridization).
- (b) RT-PCR (Reverse transcription polymerase chain reaction).
- (c) FISH (fluorescence *in situ* hybridization).
- (d) Gene capture and next generation sequencing.

14. The mutation of the KRAS gene is an important step in the development of many cancers. For example, G12C is an oncogenic mutation for the KRAS gene. In this case, G12C means:

- (a) The 12<sup>th</sup> nucleotide changes from G to C (G: wild type; C: mutant)
- (b) The 12<sup>th</sup> nucleotide changes from C to G (C: wild type; G: mutant)
- (c) The 12<sup>th</sup> codon changes from G to C (G: wild type; C: mutant)
- (d) The 12<sup>th</sup> codon changes from C to G (C: wild type; G: mutant)

(背面仍有題目，請繼續作答)

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15. The biological effect of KRAS G12C mutation is:

- (a) To reduce the GTPase activity of the KRAS protein
- (b) To increase the GTPase activity of the KRAS protein
- (c) To reduce the GTP exchange activity of the KRAS protein
- (d) To increase the GTP exchange activity of the KRAS protein

二、 填充題 (4 小題，共 15 分)

In 1986, Dr. Marilynn Kozak wrote: “- - - - A purine in position -3 (i.e., 3 nucleotides upstream from the ATG codon) has a dominant effect; when a pyrimidine replaces the purine in position -3, translation becomes more sensitive to changes in positions -1, -2, and +4. Single base substitutions around an upstream, out-of-frame ATG codon affect the efficiency with which it acts as a barrier to initiating at the downstream start site for preproinsulin. The optimal sequence for initiation defined by mutagenesis is identical to the consensus sequence that emerged previously from surveys of translational start sites in eukaryotic mRNAs. - - - -”.

The following table shows some more details. Data were compiled from 699 sequences of vertebrate genes. A window of 5 nucleotides preceding the initiator codon is presented, as well as one nucleotide (position +4) following the ATG codon. The numbers indicate the frequency of A, C, G and T around the translational start site in the 699 vertebrate mRNAs.

Position	-5	-4	-3	-2	-1	+4
Percent A	18	25	61	27	15	23
Percent C	39	53	2	49	55	16
Percent G	23	15	36	13	21	46
Percent T	20	7	1	11	9	15

**Questions:**

1. The optimal sequence mentioned above is now known as \_\_\_\_\_ consensus. (4 分)

2. The consensus sequence is: \_\_\_\_\_ ATG \_\_\_\_\_. (4 分)

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3. In the following sequence, which ATG would be the translational start site? Please judge by the consensus sequence and the behavior of ribosomes. (4 分。請將那一個 ATG 前面 6 個及後面 3 個，總共 12 個序列寫在答案卷上)

5'-GAGTGTCTTCGGCATGGCGCTGCAGCCAGCCGCGATGGGACGACA AACTTCAAAGCTA  
AATGCAGTTC-3'

4. Does the consensus sequence contain a restriction site? If yes, write down the recognition sequences of the restriction enzymes. (3 分)

### 三、問答題 (40 分)

1. Please describe three kinds of molecular mechanisms for controlling initiation of translation in eukaryotic cells (10 分).
2. Describe the amber codon, the amber suppressor, and how an amber suppressor works (10 分).
3. A proper regulation of gene transcription is very important for the well-being of human and other organisms (20 分).

(a) Please define eukaryotic gene transcription, including a key enzyme and stages involved in this process (8 分).

(b) The following is a sketch of a eukaryotic gene.



(b1) Please mark exons and introns in the sketched gene (2 分。請將圖形重畫在答案卷上作答).

(b2) Please mark and name a region in the sketched gene that is involved in the regulation of transcription (2 分。請將圖形重畫在答案卷上作答).

(b3) What is the function of a transcription factor? A transcription factor interacts with which region in a gene? (4 分)

(c) Please name and describe a method for studying the interaction between a eukaryotic gene and a transcription factor (4 分).