

國立清華大學 104 學年度碩士班考試入學試題

系所班組別：生命科學院甲組、醫學生物科技學程

考試科目（代碼）：分子生物學(0404、0704)

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*請在【答案卷】作答

I 單選題 (每題 2 分，共 56 分)

1. Biochemical and genetic experiments have demonstrated that the _____ of tRNA are important for recognition by its cognate aminotransferase-tRNA synthetase.
A. acceptor stem and anticodon loop
B. T loop and variable loop
C. anticodon loop and T loop
D. variable loop and D loop
E. D loop and T loop
2. Which of the following molecules does not resemble a tRNA molecule?
A. tmRNA
B. EF-Tu
C. puromycin
D. RRF
E. suppressor tRNA
3. Which of the following antibiotics does not inhibit protein synthesis by binding to the ribosome?
A. chloroamphenicol
B. streptomycin
C. ampicillin
D. erythromycin
E. tetracycline

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4. Put the following steps of prokaryotic translation initiation in the correct order.
- (1) Binding of IF1, IF2, and GTP to the 30S subunit.
 - (2) Binding of IF3 to the 30S subunit.
 - (3) Binding of the 50S subunit and loss of IF1 and IF3.
 - (4) Dissociation of the 70S ribosome.
 - (5) Formation of the 70S initiation complex by dissociation of IF2 and GTP hydrolysis.
 - (6) Formation of the 30S initiation complex.
- A. 1,2,3,4,5,6
B. 2,1,6,3,5,4
C. 5,6,3,2,1,4
D. 4,2,1,6,3,5
E. 2,4,1,6,3,5
5. Please place the steps of translation elongation in the correct order.
- (1) Peptidyl transferase forms a peptide bond between the peptide in the P site and the newly arrived aminoacyl-tRNA in the A site.
 - (2) EF-G, with GTP, translocates peptidyl-tRNA to the P site.
 - (3) EF-Tu, with GTP, binds an aminoacyl-tRNA to the ribosomal A site.
- A. 3, 2, 1
B. 1, 2, 3
C. 2, 3, 1
D. 1, 3, 2
E. 3, 1, 2
6. Which of the following evidence **can be considered as supports or necessity** for discontinuous synthesis of one strand of double-stranded DNA molecules?
- A. the presence of Okazaki fragments as replication intermediates
B. DNA polymerase requires a primer
C. DNA replicates unidirectionally
D. DNA replicates bidirectionally

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7. Which one concerning hybrid dysgenesis in *Drosophila* is true?
 - A. Hybrid dysgenesis occurs when the P element is contributed by the egg and sperm is devoid of P element.
 - B. Hybrid dysgenesis occurs when both parents (egg and sperm donors) carry P element.
 - C. Transposition of P element is responsible for killing somatic cells of F1 hybrid
 - D. The molecular basis of hybrid dysgenesis lies at the tissue-specific splicing of the primary transcript of transposase
8. Which one of the following process requires RecA activity
 - A. activating immunoglobulin gene rearrangement
 - B. resolving a Holliday junction during recombination
 - C. activating SOS gene expression
 - D. Integration of λ phage genome to bacterial chromosome
9. Which of the following enzyme uses RNA to synthesize DNA?
 - A. Klenow enzyme
 - B. RNA replicase
 - C. telomerase
 - D. *Escherichia coli* DNA polymerase IV
10. Which statement is not true for class I and III promoters in the eukaryotes?
 - A. For eukaryotic RNA polymerase III-dependent promoters (class III promoter), the TATA box is recognized by the general transcription factor TFIIB.
 - B. For class I promoter in human, the core-binding factor SL1 is required to recruit RNA polymerase I.
 - C. TFIIB acts as an assembly factor that binds to the internal promoter and helps TFIIA to bind to a region just upstream of the transcription start site.
 - D. TFIIA is required for transcription of the 5S rRNA genes, but not for the tRNA genes.
 - E. Although class I promoters are variable in sequence across species, they do contain the AT-rich initiator with a conserved sequence.

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11. Please choose one wrong statement for the roles of different general transcription factors in eukaryotic RNA polymerases.
- A. TATA-binding factor (TBP) is also required for transcription in the *Archaea*.
 - B. The TBP-associated factor 1 (TAF1) serves as an assembly factor around which other TAFs can aggregate and also contains a histone acetyltransferase activity.
 - C. TFIIB is a general transcription factor with its C-terminal domain to interact with RNA polymerase II and can determine the direction of transcription.
 - D. TBP-free TAF-containing complex (TFTC) can sponsor the formation of preinitiation complex of RNA polymerase II without the presence of TFIID.
 - E. The negative cofactor 2 (NC2) can stimulate RNA polymerase II-related gene transcription from downstream promoter element (DPE)-containing promoters.
12. Which of the following statement is true for gene transcription in the eukaryotes?
- A. Tfg2 is the second largest subunit of TFIIF and is homologous to bacterial alpha-subunit of RNA polymerase.
 - B. Mediator is a collection of proteins that is a part of most RNA polymerase II preinitiation complexes and is not required for transcription initiation, but is required for activated transcription.
 - C. TFIID is a general transcription factor for RNA polymerase III and contains 9 zinc finger structures in which one finger containing 6 cysteines to coordinate 2 zinc ions.
 - D. In the absence of ligand, the thyroid hormone receptor exists as inactive form in cytoplasm complexed with heat shock protein 90.
 - E. Silencers are DNA-binding proteins that can cause strong bending in DNA.
13. Please choose one of the following technique that cannot be used to quantify the level of gene expression.
- A. Nuclear run-off assay.
 - B. Northern blot analysis.
 - C. S1 mapping.
 - D. RFLP analysis.
 - E. RNase protection.

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14. Choose one wrong statement from the followings regarding eukaryotic transcription?
- A. In flowering plants, RNA polymerase IV and V are involved in gene silencing, which are performed by RNA polymerase II in other eukaryotes.
 - B. TFIIA can interfere with the interaction between TAF1 of RNA polymerase II N-terminal domain & DNA-binding surface of TBP, freeing up TATA-binding protein (TBP) for promoter binding.
 - C. Rpb10 and Rpb12 are common subunits in all three yeast polymerases.
 - D. An enhanceosome is a collection of DNA sequences (enhancers) that can enhance transcription by themselves.
 - E. The incoming nucleotide first encounters the E (“entry”) site and the “A” site of RNA polymerase II is where a phosphodiester bond forms.
15. A DNA element found in prokaryotes that binds tightly to a specific repressor and thereby regulates the expression of adjoining genes is called _____.
- A. Enhancer
 - B. Promoter
 - C. Terminator
 - D. Suppressor
 - E. Operator
16. Which of the following is a possible mechanism for the action of NusA in termination?
- A. It binds to NusB to promote detachment of the RNA polymerase for the DNA template.
 - B. It interacts with S10 to promote dissociation of the RNA polymerase.
 - C. It binds with N to promote hairpin loop formation.
 - D. It stimulates termination at intrinsic terminator by facilitating hairpin loop formation.
 - E. It binds to the RNA polymerase causing it to stall.

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17. According to the result of affinity labeling, which one of the following subunits lies near the active site of bacterial RNA polymerase where phosphodiester bonds are formed?
- A. α
 - B. β
 - C. β'
 - D. δ
 - E. ω
18. Which of the following statements is not correct about the *cro* gene?
- A. It is adjacent to the *cIII* gene.
 - B. It must be repressed during lysogeny.
 - C. It belongs to the immediate early gene.
 - D. It must be stimulated during the lytic cycle.
 - E. Its product represses repressor (CI) activity.
19. Which of the following techniques is most useful in determining whether the α -subunit of *E. coli* RNA polymerase is involved in contacting a promoter UP element?
- A. Run-off transcription assay.
 - B. Southern analysis.
 - C. DNase footprinting experiment.
 - D. Filter binding assay.
 - E. DNA sequencing.
20. Which of the following explains the events in late stage of phage SPO1 infection in *B. subtilis*?
- A. There is a high level of transcription of host genes.
 - B. Host polymerase holoenzyme directs transcription.
 - C. Phage SPO1-specific core polymerase participates in transcription.
 - D. The host core enzyme participates in transcription in conjunction with the phage-encoded specific sigma factor.
 - E. The host sigma factor specifies transcription of genes.

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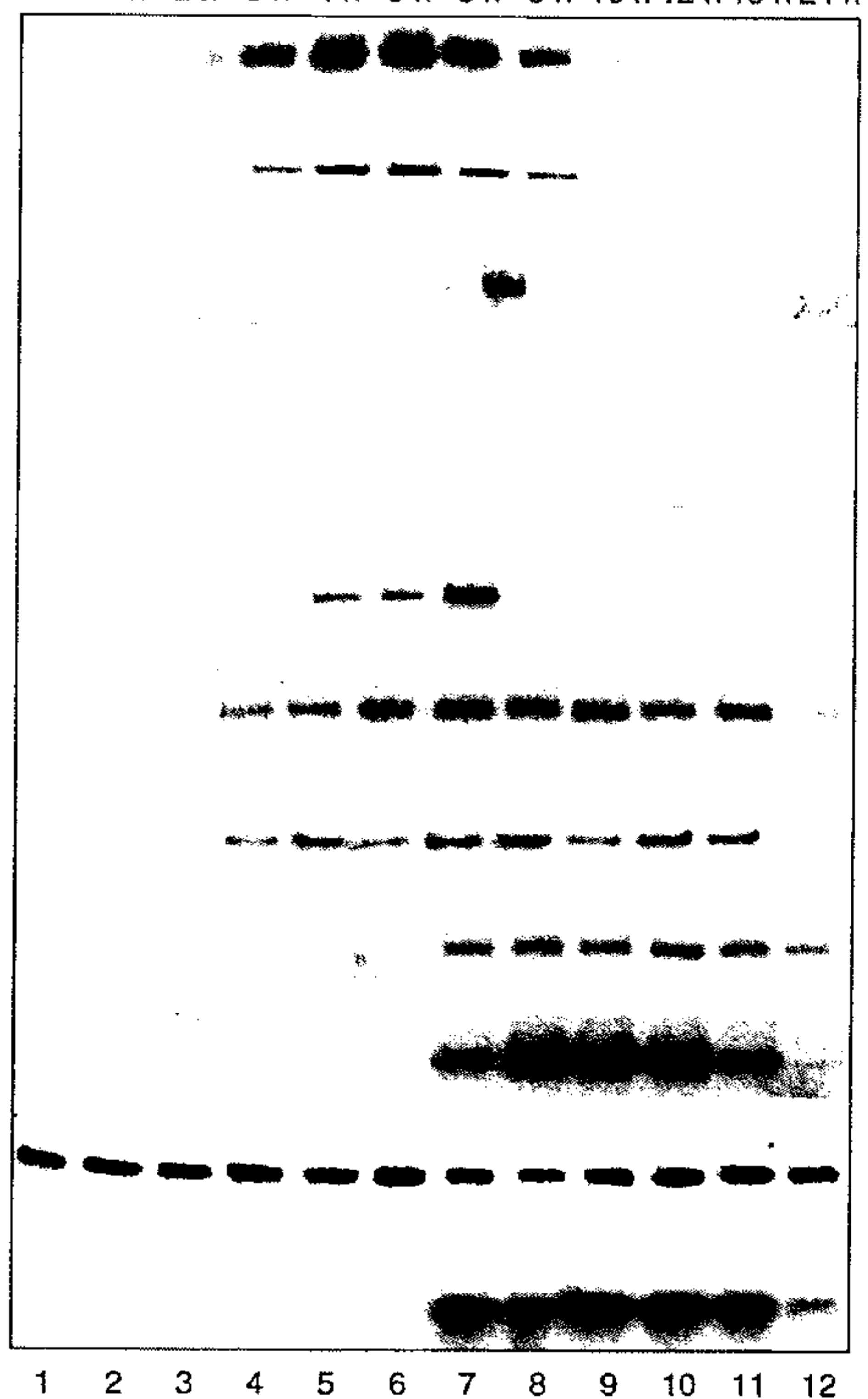
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21. Which chromatin folding is **unlikely** to occur in the putative 30-nm chromatin fiber?
- A. solenoid model
 - B. stem-loop model
 - C. Zig-Zag model
 - D. two-start double helical model
22. What is **NOT** a proposed role of Histone H1?
- A. nucleosome stabilizer
 - B. inhibitor of transcription
 - C. a linker histone
 - D. a component of the core nucleosome
23. Chromatin Immunoprecipitation (ChIP) analysis shown below revealed the timing of histone acetylation in chromatin at INF- β promoter of HeLa cells after Sendai virus infection. Which hypothesis may **NOT** be true?

Post viral infection time points:

0h 1h 2h 3h 4h 5h 6h 8h 10h 12h 19h 24h



- A. Phosphorylation of histone H3 S10 is necessary for lysine 14 acetylation.
- B. Acetylation of lysine 8 of histone H4 promotes SWI/SNF complex binding to nucleosome.
- C. Acetylation of lysine 14 of H3 is required to recruit TBP to INF-beta promoter.
- D. Acetylation of lysine 16 of H4 is required for phosphorylation on S10 of histone H3.

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24. What is the consensus sequence of mammalian pre-mRNA intron?
- A. exon/**GU-intron-AG**/exon
 - B. exon/**UU-intron-GG**/exon
 - C. exon/**CA-intron-GG**/exon
 - D. exon/**GA-intron-AA**/exon
25. Which of the following enzymes is **NOT** involved in the process of vaccinia virus and reovirus mRNA cap synthesis?
- A. Methyltransferase
 - B. RNA triphosphatase
 - C. Guanylyl transferase
 - D. RNA dependent protein kinase
26. Which eukaryotic molecule contains a poly(A) tail during their biogenesis?
- A. 5S rRNA
 - B. tRNA
 - C. U6 snRNA
 - D. mRNA
27. Which of the following descriptions about polyadenylation signal in mammalian cells is true?
- A. AAUAAA is the most frequent and active sequence.
 - B. Polyadenylation signal is followed 23-24 bp later by a UC-rich motif and then by a C-rich motif.
 - C. The cleavage/ polyadenylation site is within the polyadenylation signal sequence.
 - D. The cleavage/polyadenylation site is within the U-rich motif.
28. Which of the following RNA processing events does **NOT** take place while eukaryotic gene transcription is underway?
- A. splicing
 - B. capping
 - C. polyadenylation
 - D. cytoplasmic transportation

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II 填充題 (每題 2 分，共 4 分)

1. _____ repair system is responsible for maintaining the stability of microsatellite. Failure of this repair may increase the chance of cancer in human.
2. Many of the DNA polymerases contain _____ activity which is responsible for maintaining the accuracy of DNA replication.

III 問答題 (共 40 分)

1. What would be the effect on a G protein's activity of (a) inhibiting its GAP? (b) inhibiting its guanine nucleotide exchange protein? Give your explanation. **(5 points)**
2. What is inducible expression vector? What benefit of using it in producing recombinant proteins? **(5 points)**
3. Consider two theoretical eukaryotic transposons, A and B. Each contains an intron. Each transposes to a new location in the yeast genome and then is examined for the presence of the intron. In the new locations, you find that A has no intron, but B does. What can you conclude about the mechanisms of transposition movement for A and B from these facts? **(3 points)**
4. How the immune systems of vertebrates can produce many millions of different antibodies? **(5 points)**
5. The reverse transcription (RT) followed by real-time quantitative PCR is the technique of choice to analyze mRNA expression. (a) Please describe the principle for the real-time quantitative PCR **(5 points)** (b) Please use the $2^{-\Delta\Delta C_t}$ method to explain how real-time quantitative PCR can be used to obtain a relative expression level of the same gene from two different biosamples. **(5 points)**
6. (a) Present a model to explain attenuation in the *trp* operon in *E. coli*. **(3 points)**
(b) How is *trp* attenuation overridden in *E. coli* when tryptophan is scarce (缺乏的)? **(5 points)**
7. Describe Drosha and Mirtron pathways for human miRNA biogenesis. **(4 points)**