國立清華大學 101 學年度碩士班入學考試試題

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)

Part I. 問答題 Please answer the following questions. (total 50 points)

1. Compare and contrast the mechanisms that prokaryotes and eukaryotes use to find the translation initiation AUG codon. **(6 points)**

2. How does a tRNA serve as an adaptor between the 3-bp codons in mRNA and the amino acids in protein? **(5 points)**

3. Describe the essential enzymatic activities of proteins or RNA in translation elongation and transpeptidation. **(5 points)**

4. Describe the basic principle of 2-dimensional gel electrophoresis. **(5 points)**

5. Explain the principle of site-direct mutagenesis, and describe a method to carry out this process. **(5 points)**

6. The immediate early/delayed early/late transcriptional switching in the lytic cycle of phage λ is controlled by antiterminators. From all aspects you have learned, what are the differences between N-directed antitermination and Q-directed antitermination during lytic infection by phage λ. **(8 points)**

7. What are the two important elements of a rho-independent (intrinsic) transcription terminator? What is the key element of a rho-dependent terminator? **(5 points)**

8. Please answer the following questions regarding measurement of transcription *in vitro* and *in vivo*.

   (1) Run-off transcription is commonly used to check the efficiency and accuracy of *in vitro* transcription. Please describe how a run-off assay works. **(4 points)**

   (2) The G-less cassette transcription assay is a variation of the run-off assay. Please explain what a G-less cassette transcription assay is. **(3 points)**

   (3) Nuclear run-on transcription can be used to measure transcription rates *in vivo*. Please describe how a nuclear run-on assay works and explain how it differs from a run-off assay. **(4 points)**

Part II. 填空題 Please fill-in the blanks. (total 6 points)

1. The ends of eukaryotic chromosomes are composed of short GC-rich repeat sequences called _____. **(2 points)**

2. *Escherichia coli* base excision repair starts with the enzyme _____ clipping out the damaged base and leaving an apurinic or apyrimidinic site. **(2 points)**

3. The *Ds* transposable element of *Zea mays* cannot transpose on its own because it lacks _____. **(2 points)**

Part III. 選擇題 Single choice questions (2 points each, total 44 points)

1. Which of the following <u>is not true</u> concerning immunoglobulin gene recombination signal sequences?
   A. There is a conserved heptamer.
   B. There is a conserved nonamer.
   C. The conserved sequences are separated by a nonconserved sequence of either a 12 bp or a 23 bp sequence.
   D. Recombination occurs between a 12 bp signal and a 23 bp signal.
   E. Recombination only occurs between two heptamers.

2. Which of the following molecules serves as a primer for reverse transcriptase during retroviral replication?
   A. host snRNA
   B. host tRNA
   C. host ribosomal DNA
   D. viral RNA
   E. viral protein

3. In the *E. coli* RecBCD pathway, in order for homologous recombination to occur, which of the following proteins coats the single stranded DNA tail produced by exonuclease activity?
   A. RecA
   B. RecB
   C. RecC
   D. RecD
   E. RuvB

4. Put the following steps of *E. coli* primosome assembly in the correct order.
   (1) Primase binds.
   (2) DnaA binds to *oriC* at *dnaA* boxes.
   (3) DnaB binds to the open complex.
   (4) DnaA, RNA polymerase, and HU protein melt the DNA.
   A. 2, 4, 1, 3
   B. 2, 4, 3, 1
   C. 3, 4, 1, 2
   D. 4, 1, 2, 3
   E. 4, 2, 1, 3

5. One mechanism by which gene conversion can occur in *N. crassa* during meiosis is
   A. SOS repair
   B. mismatch repair
   C. double stranded break repair
   D. excision repair
   E. photoreactivation repair

6. Which of the following subunits of the DNA polymerase III holoenzyme is referred to as the "sliding clamp"?
   A. α
   B. β
   C. γ
   D. τ
   E. θ

7. Which of the following statements is not true concerning DNA replication in *E. coli*?
   A. DNA replication is semiconservative.
   B. DNA replication is semidiscontinuous.
   C. There are multiple origins of replication.
   D. DNA replication is RNA dependent.
   E. DNA replication requires topoisomerase.

8. Which of the following agents causes DNA damage by forming pyrimidine dimers?
   A. X-rays
   B. γ- radiation
   C. UV radiation
   D. alkylating agents
   E. ethidium bromide

9. Which of the following repair mechanisms is a damage bypass mechanism, not an actual repair mechanism?
   A. DNA photolyase
   B. base excision repair
   C. nonhomologous end joining
   D. mismatch repair
   E. recombination repair

10. Which of the following statement is not true?
   A. DRB sensitivity inducing factor (DSIF) and negative elongation factor (NELF) can help eukaryotic RNA polymerase II in the paused state.
   B. TFIIH can catalyze phosphorylation of the carboxyl-terminal domain of RNA polymerase II and is required for promoter clearance, but is not needed for transcription elongation.
   C. The signal for RNA polymerase II to leave the paused state is delivered by the positive elongation factor-b (P-TEFb).
   D. P-TEFb phosphorylates RNA polymerase II, DSIF and NELF. Next, DSIF leaves the paused complex, but NELF remains to stimulate transcription elongation.
   E. TFIIB binds to TATA-binding protein via its C-terminal domain ($TFIIB_C$) and can determine the start site of transcription.

11. Which of the following statement regarding eukaryotic RNA polymerase II is not true?
    A. The zipper of Rpb1 collaborates with the lid to initiate dissociation of the DNA-RNA hybrid.
    B. The lid of Rpb1 interacts with DNA-RNA hybrid & maintains the hybrid dissociation.
    C. The pore 1 of RNA polymerase II is the place for extrusion of the 3'end of RNA when RNA polymerase II backtracks.
    D. Alpha-amanitin blocks translocation after a phosphodiester bond forms in transcription, without blocking nucleotide entry.
    E. Bridge helix lies next to the active center of RNA polymerase II & flexing this helix may function in translocation during transcription.

12. What is the effect on the activity of eukaryotic RNA polymerase I if TAF1 is deleted from the promoter?
    A. Polymerase I will not form the preinitiation complex.
    B. Phosphorylation of the DNA-binding domain will be impaired.
    C. Transcription elongation will be slowed.
    D. Polymerase I will not form the preinitiation complex and phosphorylation of the DNA-binding domain will be impaired are correct.
    E. None of the choices is correct.

13. The Klenow (large) fragment of *E. coli* DNA polymerase I contains which of the following enzymatic activities?
    A. DNA polymerase and 3' to 5' exonuclease
    B. DNA polymerase and 5' to 3' exonuclease
    C. DNA polymerase and both 3' to 5' and 5' to 3' exonucleases
    D. only DNA polymerase
    E. only 5' to 3' exonuclease

14. Which of the following regarding structural basis of eukaryotic RNA polymerase II and its nucleotide selection is not true ?
    A. Structure of yeast RNA polymerase II shows a deep cleft that is lined with basic amino acids and can accept a linear DNA template.
    B. From structure of yeast RNA polymerase II, there is a funnel-shaped pore in the bottom of the enzyme and this pore may serve as the exit point for extruding the 3′-end of the nascent RNA.
    C. To understand how RNA polymerase II can discriminate against dNTPs, Kornberg and colleagues found that the enzyme incorporated ribonucleotides at a much slower rate than it did deoxyribonucleotides.
    D. When a correct nucleotide occupies the nucleotide-binding "A" site, the trigger loop of Rpb1 makes several important contacts with that nucleotide to presumably stabilize the nucleotide's association with the active site.
    E. The metal B enters the active site of RNA polymerase II by forming complex with the incoming nucleotide.

15. Which of the following is not true for heterogeneity of the Rpb1 subunit in eukaryotic RNA polymerase II?
    A. RNA polymerase II from plasmacytoma showed heterogeneity in its largest subunit.
    B. Subunit IIa is un-phosphorylated and is the primary product to join the preinitiation complex of yeast RNA polymerase II.
    C. The carboxyl-terminal domain of RNA polymerase II is phosphorylated prior to the formation of the initiation complex.
    D. Phosphorylation of IIa is occurred on its carboxyl-terminal domain.
    E. RNA polymerase II with IIo is involved in transcription elongation.

16. Which of the following is not a part of the eukaryotic core class II promoter?
    A. TATA box.
    B. Upstream elements.
    C. TFIIB recognition element (BRE).
    D. Downstream promoter element (DPE).
    E. Initiator (Inr).

17. An experiment was designed to obtain nonspecific transcription from both strands of a DNA molecule. Which of the following strategies would be most effective in achieving this?
    A. Use intact DNA.
    B. Add the CAP protein.
    C. Remove the sigma-factor from RNA polymerase.
    D. Include the RNA holoenzyme in the reaction.
    E. Enrich the preparation with sigma subunit.

18. Which of the following statements is <u>not true</u> about the *cro* gene?
    A. It must be stimulated during the lytic cycle.
    B. Its product represses σ repressor activity.
    C. It is adjacent to the *cII* gene.
    D. It codes for a repressor of the *cI* gene.
    E. *cro* activation is necessary for lysogeny.

19. Which of the following descriptions is <u>not correct</u>?
    A. Attenuation causes the length of the RNA molecules to be significantly shortened.
    B. Arabinose can derepress the *ara* operon by causing AraC to loosen its attachment to $araO_2$ and to bind to $araI_2$ instead.
    C. Recent experimental evidence has shown that three *lac* operator sequences are needed for maximal expression.
    D. A riboswitch is usually a region in DNA that contains an aptamer and an expression platform.
    E. The two dimmers in a *lac* repressor tetramer interact with the major groove of the DNA.

20. Which of the following techniques is most useful in demonstrating that CII and RNA polymerase bind to the opposite side of the helix in the P_{RE} region?
    A. DMS footprinting experiment.
    B. DNase footprinting experiment.
    C. Run-off transcription assay.
    D. Density gradient centrifugation.
    E. Filter binding assay.

21. Place the following in the order that they occur during transcription initiation:

1 - formation of open complex;　　2 - formation of closed complex;

3 - promoter clearance;　　4 - synthesis of about 10 nucleotides

A. 1, 2, 3, 4.

B. 2, 1, 4, 3.

C. 2, 1, 3, 4.

D. 3, 1, 2, 4.

E. 3, 2, 1, 4.

22. Select the correct statement about enhancers?

A. They are proteins that promote transcription of RNA.

B. They bind protein factors and stimulate transcription.

C. They are nonpromoter protein elements.

D. They stimulate the binding of repressor to DNA.

E. They are usually found downstream of the genes they influence.