

國立清華大學 103 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)

共 7 頁，第 1 頁

*請在【答案卷】作答

I. 單選題 (每題兩分，共四十八分)

- Regions of the 5'-UTRs of mRNAs that alter their structures to control gene expression are called _____.
(A) Enhancers
(B) Operators
(C) Leader sequences
(D) Riboswitches
(E) UP elements
- Which of the following statements is correct about a pair of *lac* operons with the following merodiploid genotype in *E. coli* strain? $I^+ O^+ Z^+ Y^+ A^+ / I^+ O^C Z^+ Y^+ A^+$ (O^C : a mutation in the operator that makes it defective in binding repressor)
(A) The mutation is *cis*-dominant.
(B) Both operons are uninducible.
(C) This merodiploid is a complete diploid bacterium.
(D) *lac* products cannot be produced in the absence of lactose.
(E) The repressor binds irreversibly to both operators.
- Which of the following statement is not correct regarding the sigma-factor?
(A) The 2.4 region has an α -helix domain.
(B) It determines rifampicin sensitivity or resistance.
(C) It can bind with core polymerase to form RNA polymerase holoenzyme.
(D) Subregions 2.4 and 4.2 are involved in promoter recognition.
(E) Interaction with the core enzyme unmask the DNA-binding region.
- Which of the following is mostly likely to occur when phage infection occurs in *B. subtilis*?
(A) Use of host σ (sigma factor) for late stage of transcription.
(B) Reduction of endospore formation.
(C) Complex sigma-switching.
(D) Complete shutdown of transcription.
(E) Use of host RNA polymerase holoenzyme for late stage of transcription.

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共 7 頁，第 2 頁 *請在【答案卷】作答

5. Which of the following is **not correct** regarding rho-dependent terminators?
- (A) Rho is a hexamer of identical subunits.
 - (B) Rho binds directly to RNA polymerase.
 - (C) Rho has helicase activity.
 - (D) They consist of inverted repeats.
 - (E) They contain several T's in the non-template strand.
6. Which of the following techniques is most useful in determining if RNA polymerase has initiated transcription from the *lac* DNA template?
- (A) Run-off transcription assay.
 - (B) Southern analysis.
 - (C) DNA fingerprinting.
 - (D) Filter binding assay.
 - (E) DNA sequencing.
7. Which of the following statement is true for transcription activators in eukaryote?
- (A) The general transcription factor TFIID has a bZIP domain that contains two cysteines and two histidines coordinated to a zinc ion.
 - (B) Some transcriptional activators can be sumoylated, which marks them for destruction by proteasome.
 - (C) Enhancers are DNA-binding proteins that can induce strong bending in DNA.
 - (D) Each homeodomain protein contains three alpha-helices in which the third serves as the DNA-recognition helix.
 - (E) Glutamine-rich domains are found to be important for DNA binding in several eukaryotic transcription factors.
8. Which statement is **true** for eukaryotic promoters?
- (A) For eukaryotic RNA polymerase II-dependent promoters (class II promoter), the TATA box is recognized by the general transcription factor TFIIB.
 - (B) Some class II promoters contain a downstream promoter element (DPE), which is located around the transcription start site.
 - (C) As an eukaryotic RNA polymerase III-dependent promoter (class III promoter), the 5S rRNA promoter is located within the gene itself (i.e. an internal promoter).
 - (D) For human rRNA promoter, it contains two important regions and the spacing between these two elements is not important for promoter strength.
 - (E) The U6 snRNA is made by RNA polymerase II and its gene promoter contains a TFIIB recognition element.

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共 7 頁，第 3 頁

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9. Crystal structures of the transcription elongation complex involving RNA polymerase II reveal a clamp, three loops of the clamp (called the *lid*, *rudder* and *zipper*), and a bridge helix.
- (A) The function of the *lid* is to initiate dissociation of the RNA-DNA hybrid.
 - (B) The *zipper* appears to play a role to maintain the dissociation of the template DNA.
 - (C) The bridge helix appears to play a role to maintain the dissociation of the RNA-DNA hybrid.
 - (D) The *rudder* is speculated to play a role in translocation during transcription.
 - (E) Alpha-amanitin is bound to a site near the bridge helix appears to enhance translocation during transcription.
10. Please choose one correct answer for the roles of different general transcription factors in eukaryotic RNA polymerase I, II and III.
- (A) TFIID has a DNA helicase activity that is essential for promoter clearance during transcription.
 - (B) The 5S RNA genes only require TFIIIB to form a preinitiation complex with the RNA polymerase III.
 - (C) The asymmetric binding of TFIIA to the promoter can determine the direction of transcription.
 - (D) The human core-binding factor SL1 is fundamental transcription factor to recruit RNA polymerase I.
 - (E) TFIIIB not only stabilizes TBP and TATA box binding, but also use an antirepression mechanism to stimulate TFIID and promoter binding.
11. Please choose one correct answer from the comparison of transcription in bacteria, archaea and eukarya.
- (A) Polycistronic mRNA is present in the archaea and the bacteria.
 - (B) The archaea and the eukarya contains three DNA-dependent RNA polymerases.
 - (C) Capping and mRNA splicing are present in the archaea and the eukarya.
 - (D) Introns are commonly present in mRNA of the archaea and eukarya.
 - (E) RNA polymerases from the bacteria and the eukarya are sensitive to rifampicin

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共 7 頁，第 4 頁

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12. Which of the following methods can be used to assay protein-protein interactions?
- (A) Chromatin immunoprecipitation
 - (B) Northern blot
 - (C) Far western
 - (D) Primer extension
 - (E) Yeast two-hybrid assay
13. Which of the following is associated with active chromatin in eukaryotic cells?
- (A) DNase hypersensitivity sites
 - (B) Nucleosome-free zones
 - (C) DNA hypermethylation sites
 - (D) Histone tail deacetylation
 - (E) Histone tail cross-linking
14. The functions of poly(A) tail **do not** include:
- (A) Half-life of mRNA
 - (B) Splicing
 - (C) mRNA transport
 - (D) Enhanced transcription
 - (E) Increased translatability
15. About siRNA-mediated RNA interference, which of the following statement is **not true**?
- (A) Needs trigger dsRNA
 - (B) Dicer cuts trigger dsRNA into 21-23 nt siRNA
 - (C) The sense-strand of siRNA is delivered to RISC for base-pairing with target mRNA
 - (D) Ago2 (slicer) in RISC has RNase H-like activity and cleaves target mRNA
16. About RNA editing in lower eukaryotes, which statement is **not true**?
- (A) Could be insertion or deletion of U
 - (B) Needs guide RNA (gRNA) to direct editing
 - (C) The second gRNA hybridizes near the 5'-end of edited regions
 - (D) Most of the new base pairs are wobble C-U pairing.

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共 7 頁，第 5 頁 *請在【答案卷】作答

17. Which of the following is **not** involved in the generation of microRNA?
- (A) Ago2
 - (B) Dicer
 - (C) Drosha
 - (D) Trigger ssRNA
 - (E) Stem-loop dsRNA precursor
18. Which of the following statement concerning the *Ac-Ds* of maize is **not true**?
- (A) These DNA elements can induce chromosome breakage
 - (B) These DNA elements can induce the formation of dicentric chromosome
 - (C) *Ac* element transposes by a replicative mechanism
 - (D) *Ds* element cannot induce chromosome breakage by itself
 - (E) *Ds* element cannot transpose by itself
19. Which of the following molecules serves as a primer for reverse transcriptase during retroviral replication?
- (A) host snRNA
 - (B) viral RNA
 - (C) host tRNA
 - (D) viral DNA
 - (E) host DNA
20. Which one of the following process requires a RecA activity
- (A) activating immunoglobulin gene rearrangement
 - (B) resolving a Holliday junction during recombination
 - (C) resolving cointegrate form during transposition
 - (D) activating SOS gene expression
 - (E) Integration of λ
21. Which of the following enzymatic activities is involved in replicating the ends of eucaryotic chromosomes?
- (A) DNA-dependent DNA polymerase
 - (B) RNA-dependent RNA polymerase
 - (C) RNA-dependent DNA polymerase
 - (D) Klenow enzyme
 - (E) DNA-dependent RNA polymerase III

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共 7 頁，第 6 頁

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22. 5-bromouracil (a base analog) induces mutations by
- (A) removing bases from DNA.
 - (B) inducing tautomeric shifts.
 - (C) inducing anti _ syn transitions.
 - (D) intercalating into the DNA.
 - (E) inactivating repair enzymes.
23. 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
24. Four different single-stranded plasmids, A, B, C, and D are added to a tube containing substrates for DNA replication. Oligonucleotides complementary to the plasmids A, B and C were annealed to the respective plasmids. Then, plasmid A is preloaded with DNA polymerase III holoenzyme, and plasmid B is preloaded with β -clamp. What is the order of plasmid replication?
- (A) All plasmids replicate at the same time.
 - (B) Plasmids A and B replicate first and then plasmids C and D.
 - (C) Plasmid A replicates first and then plasmid C, and plasmid D is the last replicated one. Plasmid B will not be replicated.
 - (D) Plasmid A replicates first. Plasmids B, C and D replicate later.
 - (E) Plasmid A replicates first, followed by plasmids B and C (in order). Plasmid D will not be replicated.

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共 7 頁，第 7 頁

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II. 問答題 (共五十二分)

1. (a) Please define the following two terms: Lysogen and prophage. (4 points)
(b) Explain how the race between the products of the *cI* and *cro* genes determines whether a given *E. coli* cell is lytically or lysogenically infected by phage λ (4 points)
2. Type I and type II nuclear receptors work differently in transcriptional regulation. Please describe and explain the different mechanisms of action for these two types of regulators in the presence and absence of their ligands? (8 points)
3. Please describe the two major types of histone modifications and their role in gene regulation. (5 points)
4. Please describe the steps of mRNA splicing, starting from a nascent pre-mRNA. (5 points)
5. Describe and give the results of an experiment that shows the role (if any) of GTP hydrolysis in (a) forming the 30S translational initiation complex, and (b) releasing IF2 from the ribosome. (6 points)
6. Compare the poliovirus virus genetic material with a typical mammalian mRNA. How does the virus take advantage of this difference to interfere with the translation? (7 points)
7. What are microsatellites and minisatellites? Which of these two tools is better for linkage mapping? Why? (7 points)
8. Explain how the **signals for V(D)J joining** ensure that one and only one of each of the parts of an immunoglobulin gene will be included in the mature, rearranged gene. (6 points, a brief explanation of the signals for V(D)J joining is sufficient)