

題號： 395

國立臺灣大學 111 學年度碩士班招生考試試題

科目： 分子生物學(D)

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I. Choose the one which best completes each of the following statements or answers each of the following questions. (2% for each question, 50% in total) ※ 注意：請於試卷內之「選擇題作答區」依序作答。

- In the method of performing Frederick Sanger Sequencing, what is the main molecule used in the reaction that may be radioactively or fluorescently labelled for detection in automated sequencing machines?
  - dNTP
  - ddNTP
  - rNTP
  - ddATP
  - rATP
- Which of the following is NOT true about genome structure and DNA replication?
  - Introns are frequently present in prokaryotic genes but are rare in eukaryotic genes
  - DNA replication is always 5' to 3'
  - Heterochromatin, rather than euchromatin, is tightly packed chromatin
  - H2A, H2B, H3, and H4 form the core of a nucleosome
  - None of the above
- The proofreading function of DNA polymerase involves all of the following except:
  - a 3' to 5' exonuclease
  - base pairing
  - steric exclusion for rNTP
  - phosphodiester bond hydrolysis
  - reversal of polymerization reaction
- Sandy wants to amplify a DNA sequence by Polymerase Chain Reaction (PCR). What is NOT essential for this experiment?
  - Primer
  - dNTP
  - oligo dT
  - Mg<sup>2+</sup> buffer
  - DNA polymerase
- Which of the following IS TRUE?
  - RNA polymerase requires primers to initiate RNA synthesis
  - Transcription is terminated at stop codons in the mRNA
  - DNA replication is initiated at promoter sequences in the DNA
  - Okazaki fragments are the short fragments of DNA that are produced on the leading strand at the replication fork
  - None of the above
- One organism contains 31% adenosine in genome. Which statement is correct?
  - It should have 31% cytosine
  - It should have 31% guanine
  - It should have 24% thymine
  - It should have 24% guanine
  - None of them is correct
- Telomerase
  - creates a short DNA sequence complementary to the DNA template
  - creates a short RNA sequence complementary to the DNA template
  - creates a short DNA sequence complementary to the RNA template
  - creates a short RNA sequence complementary to the RNA template
  - solves the end replication problem in the leading strand
- All of the following elements can function as prokaryotic promoter except
  - a TATA box centered at ~ -10
  - a purine at the start point
  - CpG islands
  - A hexamer with a sequence close to TTGACA centered at ~ -35
  - all of the above

見背面

9. The transient covalent modification of the N-terminal tails of the core histone proteins:
- A. facilitates the process of transcription and DNA replication
  - B. disrupts nucleosome/DNA interaction by the introduction of a net positive charge on the nucleosomes
  - C. is specific for the R groups of valine, isoleucine and alanine
  - D. Exclusively involve the histone tails of H2A and H2B
  - E. Answers A and B are correct
10. An open reading frame (ORF) that is not likely to encode a functional polypeptide usually has the following feature not found in other ORF.
- A. It has many termination codons
  - B. It has many coding triplets before a termination codon
  - C. It has an initiation codon
  - D. It encodes functional polypeptides in the other two reading frames of the same sequence
  - E. It is never transcribed
11. What type of DNA structure is needed for initiation of homologous DNA recombination?
- A. broken, blunt-ended DNA
  - B. a free 5' single stranded region
  - C. a free 3' single stranded region
  - D. any of the above
  - E. none of the above
12. Which of the following enzymes will produce a blunt end (the cut site is indicated by the \* in the recognition sequence)?
- A. *TaqI* (T\*CGA)
  - B. *EagI* (C\*GGCCG)
  - C. *EcoRI* (G\*AATTC)
  - D. *BamHI* (G\*GATCC)
  - E. *SmaI* (CCC \*GGG)
13. Which of the following statements about RNA polymerase is NOT correct?
- A. DNA moves through a channel in RNA polymerase and makes a sharp turn at the active site
  - B. Sigma factor is required for both the initiation and elongation steps of RNA synthesis
  - C. Sigma factor changes the DNA-binding properties of RNA polymerase so that its affinity for general DNA is reduced and its affinity for promoter is increased
  - D. Core RNA polymerase of bacteria can synthesize RNA from a DNA template but cannot initiate transcription at the correct site
  - E. None of the above (All are correct)
14. Which of the following statements about Eukaryotic RNA polymerases and promoters is NOT correct?
- A. mRNA is synthesized by RNA polymerase II in the nucleoplasm
  - B. rRNA is synthesized by RNA polymerase I in the nucleolus
  - C. Promoter is always located in the upstream of the transcription start point
  - D. Chromatin must be opened before RNA polymerase can bind the promoter
  - E. None of the above (All are correct)
15. Which of the following is not used in the electrophoretic mobility shift assay (EMSA)?
- A. A radiolabeled DNA fragment
  - B. A polyacrylamide gel
  - C. A DNA binding protein
  - D. DNaseI
  - E. Non-labeled or mutated DNA fragment
16. The process by which a recombinant DNA (transgene) is introduced into the host is called:
- A. Ligation
  - B. Recombination
  - C. Screening
  - D. Selection
  - E. Transformation

17. Fluorescent in-situ hybridization (FISH) is used to:
- Map the location of chromosomes undergoing metaphase
  - Map DNA sequences from a specific parent in an individual
  - Map transcription factor binding sites on a chromosome
  - Map actively transcribed genes in heterochromatin
  - Map DNA sequences and genes to a chromosomal position
18. A woman with heterozygosity for a mutation in the dystrophin gene (one normal and one mutant copy) is almost as severely affected with Duchenne muscular dystrophy as her maternal uncle who died at age 23 as a result of the condition. Knowing that the dystrophin gene is located on the X chromosome, what most likely accounts for this woman's severe symptoms?
- She has only one X chromosome (X)
  - She has too many X chromosomes (XXX)
  - Her cells preferentially inactivated the normal X chromosome
  - She has one inactivated Y chromosome (Y)
  - None of the above
19. Which of the following processes is unique to bacteria?
- Coupled transcription and translation
  - Cotranslational transport
  - Chaperone-aided protein folding
  - Post translational protein modifications
  - Catalytic RNAs in ribonucleoprotein complexes
20. A western blot of a normal (N) and patient (P) sample is represented below. What conclusions can be drawn from these results regarding "X"?
- |     |   |   |
|-----|---|---|
|     | N   | P |
| X → |  |   |
- The patient has less DNA for gene X relative to normal
  - The patient has less RNA for gene X relative to normal
  - The patient has less protein X relative to normal
  - The patient has more protein X relative to normal
  - The patient has more DNA for gene X relative to normal
21. Bob is a 58 year old man who has worked for over 20 years in a plant involved in the manufacturing of batteries. As a result of cadmium (鎘) exposure, the promoter regions of several tumor suppressor genes were hypermethylated causing decreased expression of these genes. Bob is diagnosed with bladder cancer. Bob's cancer is an example of a \_\_\_\_\_ cancer that is due to a(n) \_\_\_\_\_ change. Which of the following fills the above blanks in the correct order?
- familial, genetic
  - familial, epigenetic
  - sporadic, genetic
  - sporadic, epigenetic
  - hereditary, epigenetic
22. Two patients with non-Hodgkin's lymphoma responded differently to therapy, suggesting that their lymphomas could be of different subtypes. Since the existing procedures for classifying the lymphomas could not confirm this possibility unambiguously, it was decided to compare the mRNA expression profiles of the cancer cells obtained from the two patients. Which of the following methods would you most likely use for determining the mRNA expression profiles?
- genomic library construction
  - Southern blot analysis
  - fluorescence in situ hybridization (FISH)
  - Western blot analysis
  - transcriptomics

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23. The mRNA for the Alzheimer-related gene is 1200 nucleotides long when isolated from neurons, but 1600 nucleotides long when isolated from glial cells. Genomic DNAs isolated from the two cell types show the identical nucleotide sequence. Which of the following mechanisms best accounts for the difference in the sizes of the mRNAs?
- site-specific recombination
  - transposition
  - alternative splicing
  - post-translational modification
  - variations in terminal glycosylation
24. There are 20 primary amino acids specified by the genetic code. Which step in the translation process requires a separate and specific enzyme for each amino acid?
- joining an individual amino acid to its specific tRNA
  - delivering aminoacyl-tRNAs to the ribosome
  - initiating translation
  - peptide bond formation
  - translocation of the ribosome to the next codon along the mRNA
25. Angelina Jolie underwent an elective double mastectomy (乳房切除術) due to an inherited familial mutation in the gene *BRCA1*. In Miss Jolie, what DNA repair pathway would likely be defective due to a mutation in this gene?
- Direct oxidative repair
  - Nucleotide excision repair
  - Base excision repair
  - Homologous recombination repair
  - Nonhomologous end joining

**II. Explain the following terms (9%)** ※ 注意：請於試卷內之「非選擇題作答區」標明題號依序作答。

- Central dogma (3 pts)
- Alternative splicing (3 pts)
- Holliday junction (3 pts)

**III. Answer the following questions (41%)** ※ 注意：請於試卷內之「非選擇題作答區」標明題號依序作答。

29. The sequence of the mRNA transcript of gene X is 5'-UUCGACAUUC-3'. What is the sequence of the corresponding DNA coding strand? Please indicate the 5' and 3' terminal. (2%)
30. What is the key protein that contributes to the high processivity of a DNA polymerase? (2%)
31. Histone modification is one of the mechanisms to change DNA accessibility. (7%)
- (2 pts) What does H4K16Ac mean?
  - (2 pts) What is the enzyme responsible for the modification mentioned in (1)?
  - (3 pts) How does the acetylation of histone affect DNA accessibility?
32. Please define the following terms: (9%)
- (3 pts) Ribozymes
  - (3 pts) Topoisomerases
  - (3 pts) Kozak sequence
33. Please compare pri-miRNA and pre-miRNA (6%)
34. What is wobble hypothesis? (3%) What is the importance of wobble and degeneracy? (3%)
35. What is CRISPR-Cas system in bacteria? Please describe how bacteria defend themselves against invading pathogens using CRISPR RNAs. (6%)
36. A group of smart genetic engineers have designed a cow that produces low lactose milk. They produced the enzyme lactase (normally secreted by intestinal cells) in mammary glands. Please design a cow to produce low lactose milk but don't damage the meat by expressing this enzyme in other cells. Draw any diagram(s) on the answer sheet showing what DNA constructs you would make to generate this cow. (3%)

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