

國立中央大學100學年度碩士班考試入學試題卷

所別：生命科學系碩士班 分子與細胞生物組(一般生) 科目：分子生物學 共 5 頁 第 1 頁  
生命科學系碩士班 分子與細胞生物組(在職生)

本科考試禁用計算器

\*請在試卷答案卷(卡)內作答

參考用

一、Multiple Choice 單選題 (70%; 2% each)

1. A nucleosome is composed of a core of \_\_\_\_\_ histone molecules and a DNA of approximately \_\_\_\_\_ bp in length.  
(a) two; 100 (b) four; 100 (c) eight; 100 (d) two; 200 (e) four; 200 (f) eight; 200
2. Which of the following statements about mRNA stability is **incorrect**?  
(a) The cap (a modification at the 5' end of mRNA) prevents 5'-3' exonucleases from attacking the 5' end.  
(b) The poly(A) prevents 3'-5' exonucleases from attacking the 3' end.  
(c) The most common location for destabilizing elements is within the 5' untranslated region.  
(d) Within the coding region, mutations that create termination codons trigger a surveillance system that degrades the mRNA.  
(e) Degradation of mRNA in yeast starts with removal of the poly(A) tail.
3. Which of the following methods is **not** used to map and/or quantify transcripts?  
(a) Northern blotting (b) Restriction mapping (c) S1 nuclease mapping (d) Primer extension  
(e) RNase mapping (RNase protection assay) (f) Run-off transcription.
4. Which of the following about DNA methylation is **false**?  
(a) Methylation of DNA occurs in both prokaryotes and eukaryotes but the purpose is quite different.  
(b) Methylation of DNA is often used to control gene expression during development of higher organisms.  
(c) DNA methylation in eukaryotes activates gene expression.  
(d) CpG island denotes a region of DNA containing many unmethylated CpG sequences.  
(e) Demethylases are used to remove methyl groups in higher organisms.
5. A "homeobox"  
(a) is a promoter-enhancing element present in genes of many or even all eukaryotes.  
(b) is a sequence important in binding of transcriptional factors.  
(c) functions as a repressor for gene expression.  
(d) encodes a homeodomain with three  $\alpha$ -helices important in protein-protein interaction.  
(e) is a common coding motif in homeotic genes important in controlling the developmental fate of groups of cells.
6. Which of the following about "splicing" is **false**?  
(a) snoRNPs participate in splicing of pre-mRNAs.  
(b) snRNAs can recognize the 5'- and 3'-splicing signals of an mRNA precursor.  
(c) The spliceosome is a complex of the snRNPs and many additional protein factors that are required for splicing.  
(d) The GU-AG motif is commonly used to predict the intron splicing sites.  
(e) The spliceosome cycle includes the assembly, splicing activity, and disassembly of the spliceosome.
7. Which of the following statements about DNA replication is **false**?  
(a) DNA replicates in a semiconservative manner.  
(b) DNA polymerase synthesizes the leading strand continuously in the 5'→ 3' direction.  
(c) DNA polymerase synthesizes the lagging strand discontinuously in the 5'→ 3' direction.

注意：背面有試題

國立中央大學100學年度碩士班考試入學試題卷

所別：生命科學系碩士班 分子與細胞生物組(一般生) 科目：分子生物學 共 5 頁 第 2 頁  
生命科學系碩士班 分子與細胞生物組(在職生)

本科考試禁用計算器

\*請在試卷答案卷(卡)內作答

參  
考  
用

- (d) DNA replication in bacteria involves synthesis of a short RNA primer by RNA replicase.  
(e) The lagging strand is made in short sections and a new RNA primer needs to be inserted each time a new portion is made.
8. Transfection  
(a) is a process in which eukaryotic cells are transformed by introducing foreign DNA into the cells. (b) occurs when a bacterium acquires DNA from the surrounding environment. (c) is the direct transfer of DNA from one bacterium to another. (d) is the result of gene recombination. (e) occurs when a phage transfers DNA from one bacterium to another.
9. Ribonuclease H (RNase H)  
(a) degrades the RNA strand of an RNA-DNA hybrid. (b) degrades single-stranded RNA at the 3' ends.  
(c) degrades single-stranded RNA and DNA. (d) degrades single-stranded RNA at the 5' ends. (e) none of the above
10. Which of the following is **not** a second messenger?  
(a) nitric oxide (b) GTP (c) diacylglycerol (d) cAMP (e) inositol-1,3,5-triphosphate (f)  $Ca^{2+}$
11. Which of the following statements about Holliday junction is **incorrect**?  
(a) Holliday junction is generated during homologous recombination.  
(b) Nicks must occur in corresponding positions in one strand of each DNA duplex.  
(c) The branch in the Holliday junction undergoes "branch migration".  
(d) The Holliday junction can be resolved into two independent DNA duplexes by creating the second DNA nicks.  
(e) If the same DNA strands are nicked after the Holliday junction formation, crossover recombination occurs.
12. Which of the following techniques is often used to generate 'traditional' (or constitutive) knockout mice?  
(a) PCR-based technique (b) gene targeting by homologous recombination (c) enucleation of embryonic stem cell (d) Cre-loxP system (e) *in vitro* fertilization
13. Which of the following statements is **false**?  
(a) DNA gyrase introduces negative supercoils into DNA.  
(b) DNA helicase unwinds the DNA helix and single strand binding protein keeps the strands apart.  
(c) Quinolone antibiotics, such as nalidixic acid, kill bacteria by inhibiting DNA gyrase and thereby preventing DNA replication.  
(d) DNA ligase inserts a segment of dsDNA into another DNA molecule at a specific recognition sequence.  
(e) Reverse transcriptase uses single-stranded RNA as a template for making double-stranded DNA.
14. Which of the following statements about immunoglobulin gene rearrangement is (are) true?  
(a) Rearrangement of a heavy chain gene involves the joining of V, D and J segments.  
(b) There are similar numbers of V and J segments in the human light chain genes.  
(c) Once a productive rearrangement has occurred at one allele, the other allele also undergoes rearrangement.

注：背面有試題

國立中央大學100學年度碩士班考試入學試題卷

所別：生命科學系碩士班 分子與細胞生物組(一般生) 科目：分子生物學 共 5 頁 第 3 頁  
生命科學系碩士班 分子與細胞生物組(在職生)

本科考試禁用計算器

\*請在試卷答案卷(卡)內作答

參考用

- (d)  $V_H$  7-12-9::9-23-7  $J_H$  are two recombination signal sequences required for a permitted somatic recombination event in the heavy chain gene.  
(e) All of the above are true.
15. A DNA segment contains a coding region of 1920 base pairs. What is the approximate calculated molecular weight of its encoded protein?  
(a) 35 kDa (b) 70 kDa (c) 19 kDa (d) 190 kDa (e) none of the above
16. Anti-codon loops are found in (a) mRNA (b) rRNA (c) tRNA (d) hnRNA (e) snRNA.
17. Which of the following terms could describe a situation in which there are multiple functional alleles of a gene segregating in a population?  
(a) somatic hypermutation (b) meiotic nondisjunction (c) loci (d) complementation  
(e) polymorphism
18. Which of the following assay **cannot** be used to detect protein-protein interactions?  
(a) immunoprecipitation (b) fluorescence resonance energy transfer (FRET) (c) yeast two-hybrid  
(d) Enzyme-linked immunosorbent assay (ELISA) (e) protein footprinting
19. Which of the following dyes is most commonly used in staining DNA on an agarose gel?  
(a) bromophenol blue (b) ethidium bromide (c) Silver stain (d) xylene cyanol (e) Coomassie blue
20. Which of the following methods is commonly used to determine the concentration of RNA?  
(a) absorbance at 260 nm (b) Northern blot (c) Bradford method (d) Lowry assay (e) RT-PCR
21. When *white* gene is integrated into the genomic site close to heterochromatin, cells in which *white* gene is inactive give patches of white eyes, while cells in which *white* is active give red patches. This phenomenon in which genetically identical cells express different phenotypes is called as \_\_\_\_\_.  
(a) X chromosome inactivation (b) Genetic imprinting (c) Genetic variation (d) position effect variegation (e) Gene silencing (f) Site-directed mutagenesis
22. The transcription of eukaryotic ribosomal RNA genes, rDNAs, is performed by \_\_\_\_\_.  
(a) RNA polymerase I (b) RNA polymerase II (c) RNA polymerase III (d) RNA polymerase A  
(e) reverse transcriptase (f) Poly (A) RNA polymerase
23. What DNA-binding motif is used by the steroid hormone receptor to bind DNA?  
(a) Cys2/Cys2 Zinc finger (b) bHLH (c) Lucine zipper (d) Helix-turn-helix (e) Cys2/His2 Zinc finger (f) homeodomain
24. The modification of amino acid residues in the N-terminal domains of H3 and H4 histones serve as a recognition code for various transcription factors. Among these modifications, methylation of the lysine 9 of H3 serves as a repressive signal and is recognized by the \_\_\_\_\_ of HP1 protein.  
(a) chromodomain (b) Lysine-rich domain (c) Glycine-rich domain (d) shadow domain  
(e) homeodomain (f) bromodomain
25. The \_\_\_ enzyme catalyzes the double strand break reaction during the early stage of meiosis recombination.  
(a) RecA (b) DNA polymerase  $\alpha$  (c) DNA polymerase  $\sigma$  (d) Ruv AB complex (e) Spo11  
(f) Topoisomerase II

注意：背面有試題

所別：生命科學系碩士班 分子與細胞生物組(一般生) 科目：分子生物學 共 5 頁 第 4 頁  
生命科學系碩士班 分子與細胞生物組(在職生)

本科考試禁用計算器

\*請在試卷答案卷(卡)內作答

參考用

26. In a particular human family, Peter and his father both have brachydactyly (BR, a very rare autosomal dominant mutation causing short fingers). His mother has Huntington disease (HD, another rare autosomal dominant mutation). Two-thirds of people who inherit the HD allele show symptoms by age 45, and Peter is 47 and has no symptoms. Brachydactyly is 90% penetrant. Both HD and BR homozygous are embryonic lethal. The following are the gene symbols for alleles of these two genes:  
**B:** mutant brachydactyly allele; **b:** wildtype brachydactyly allele  
**H:** mutant Huntington allele; **h:** wildtype Huntington allele  
 What are the genotypes of Peter's parents for these two genes?  
 (a) father is bb Hh and mother is Bb hh (b) father is bb Hh and mother is Bb HH (c) father is BB Hh and mother Bb hh (d) father is bb Hh and mother is BB hh (e) mother is bb Hh and father is Bb hh (f) both are Bb Hh
27. Following question 6, if the two loci are 20 m.u. apart, what is the possibility that Peter will carry mutant alleles of both Brachydactyly and Huntington genes?  
 (a) 3/10 (b) 1/4 (c) 1/6 (d) 1/2 (e) 5/8 (f) 2/3
28. Which of the following description about the activation of *trp* operon genes in the absence of tryptophan is correct?  
 (a) leader peptide is translated efficiently and *trp* operon is transcribed completely  
 (b) RNA polymerase is stalled and regions 2 and 3 of the attenuator paired  
 (c) leader peptide is translated efficiently and regions 1 and 2 of the attenuator paired  
 (d) neither leader peptide is translated efficiently nor *trp* operon is transcribed  
 (e) RNA polymerase is stalled and regions 1 and 3 of the attenuator paired  
 (f) RNA polymerase is stalled and regions 3 and 4 of the attenuator paired
29. The lariat product of spliced intron can be seen in the \_\_\_\_ complex of spliceosome during mRNA splicing.  
 (a) A (b) B (c) C (d) D (e) E (f) F
30. Promoter clearance takes place \_\_\_\_.  
 (a) after homologous recombination (b) before TBP binding to TATA box (c) before TFF<sub>IIH</sub> binding  
 (d) after RNA polymerase II dissociate from the enhancer (e) after 10 bp nascent mRNA has been made  
 (f) before 10 bp nascent mRNA has been made
31. The catalytic center of *E. coli* RNA polymerase is formed by \_\_\_\_.  
 (a)  $\alpha\alpha$  subunits (b)  $\beta\beta$  subunits (c)  $\beta\beta'$  subunits (d)  $\beta\sigma$  subunits (e)  $\beta\sigma$  subunits (f)  $\alpha\beta$  subunits
32. The products of a Dicer processed miRNA are \_\_\_\_.  
 (a) short hairpin RNA (b) tandem repeat RNA (c) double strand short RNA (d) single strand RNA  
 (e) single strand DNA (f) double strand short DNA
33. The destination of an un-perfectly matched siRNA/mRNA complex is \_\_\_\_.  
 (a) Cajal Body (b) RISC (c) RITS (d) lysosome (e) Dicer (f) P body
34. Translational initiation factors eIF4E and eIF4G recognize the \_\_\_\_ and \_\_\_\_ features of the mRNA respectively to ensure the initiation of translation.

注意：背面有試題

國立中央大學100學年度碩士班考試入學試題卷

所別：生命科學系碩士班 分子與細胞生物組(一般生) 科目：分子生物學 共 5 頁 第 5 頁  
生命科學系碩士班 分子與細胞生物組(在職生)

本科考試禁用計算器

\*請在試卷答案卷(卡)內作答

參考用

(a) Poly (A) tail/5'-7-methyl-guanine (b) 5'-7-methyl-guanine /Poly (A) tail (c) 5'-CAP/ribosome entry site (d) 5'-CAP/Shine-Dalagarno sequence (e) TATA box/ Poly (A) tail (f) Shine-Dalagarno sequence/ Poly (A) tail

35. The consensus sequence of higher eukaryotic mRNA polyadenylation signal is \_\_\_\_\_.

(a) AAUAAA (b) AAUATT (c) TTUAAA (d) AATCCC (e) ATGCAAA (f) TAGTAG

二、Essay questions (30%)

1. Please define and/or explain the following terms. (10%; 2.5% each)

(a) frameshift mutation (b) DNA fingerprinting (c) palindrome (d) short interfering RNA

2. Please describe the organization of nucleosomes in a 30 nm chromatin fiber. (4%)

3. Please describe the transcriptional regulation circuits that initiate and maintain lambda phage latency. (6%)

4. A student likes to make a fusion protein of EGFP and p53 so he can trace the dynamic subcellular localization of p53 before and after the cells have been assaulted with UV radiation. So far, he has pEGFP-C1 and pEGFP-N1 vectors carrying the CDS of EGFP gene for inserting p53 CDS into its C-terminal and N-terminal sites respectively. He also has a pCDNA3.1 vector carrying p53 CDS. Unfortunately, the cutting sites in these 3 mammalian expression vectors are incompatible for making p53-EGFP and EGFP-p53 proteins.

(a) What will you do to make these two fusion proteins with these vectors? (3%)

(b) How can you introduce these new expression vectors into mammalian cells? (3%)

(c) He found that GFP-p53 protein accumulated rapidly and abundantly in the nucleus upon UV assault but was detected very weakly in both nucleus and cytoplasm under normal condition. He also found that the mRNA level of GFP-p53 remained constant during this period. What can be the causes of this phenomenon? (4%)