

THE UNIVERSITY OF CHICAGO

PH.D. THESIS

DEPARTMENT OF CHEMISTRY

PHYSICAL CHEMISTRY

BY

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一、單選題 (36%)：每題 2 分，請於試卷內之「選擇題作答區」依序作答。

1. Common types of mutations that arise in DNA replication include
  - A) the mismatch of bases in the DNA.
  - B) the deletion of one or more bases in the DNA.
  - C) the insertion of one or more bases in the DNA.
  - D) B and C.
  - E) A, B, and C.
  
2. Most eukaryotic RNA consists of coding regions, called \_\_\_\_\_, and noncoding regions, called \_\_\_\_\_.
  - A) introns; exons
  - B) exons; introns
  - C) spliceons; codons
  - D) codons; spliceons
  - E) introns; codons
  
3. One function of the RecA protein in recombination events is to:
  - A) produce an endonucleolytic nick on dsDNA.
  - B) aid in recognition of *Chi* site by the RecBCD complex.
  - C) initiate recombination.
  - D) catalyze the ATP-dependent DNA strand exchange reaction.
  - E) drive branch migration and process the Holliday junction into recombinant products.
  
4. All are characteristics of transposons EXCEPT:
  - A) segments of DNA moved non-enzymatically in the genome.
  - B) unstable location within genome.
  - C) range in size from hundreds of bps to 8 kbp.
  - D) the smallest transposons are called insertion sequences.
  - E) a major force in evolution.
  
5. The exchange of one base for another is called a \_\_\_\_\_, while insertions and deletions are referred to as \_\_\_\_\_.
  - A) frameshift mutation; transition mutations
  - B) frameshift mutation; point mutations
  - C) point mutation; transversion mutations
  - D) point mutation; frameshift mutations
  - E) transition mutation; transversion mutations
  
6. DNA footprinting is a technique that allows one to determine
  - A) the homology between various DNA sequences.
  - B) how proteins interact with each other when bound to DNA.
  - C) where proteins bind to DNA.
  - D) All of the above.
  - E) None of the above.

見背面

7. The structure of DNA must be in the \_\_\_\_\_ for transcription to occur.
- A) closed promoter complex
  - B) biphasic promoter complex
  - C) open promoter complex
  - D) All of the above
  - E) None of the above
8. RNA modification in prokaryotes includes
- A) cleavage and modification of nascent RNA.
  - B) addition of nucleotides.
  - C) spliceosome-mediated splicing of the nascent RNA.
  - D) A and B.
  - E) A, B, and C.
9. The key event in eukaryotic transcriptional activation is
- A) binding of the TATA-box-binding protein (TBP) to the TATA box.
  - B) binding of the SP-1 protein to the CAAT box.
  - C) binding of the RNA polymerase 500 base pairs upstream of the CAAT and TATA boxes.
  - D) All of the above.
  - E) None of the above.
10. The carboxyl-terminal domain (CTD) of RNA polymerase II is involved in
- A) binding to promoter regions of DNA.
  - B) formation of the transcription bubble.
  - C) coordinating post-transcriptional processing events.
  - D) recognition of the termination signal.
  - E) None of the above.
11. Which of the following accounts for the greater complexity in eukaryotic transcriptional control when compared with prokaryotic control?
- A) physical separation of transcription from translation
  - B) the presence of chromatin instead of naked DNA
  - C) the larger size of the chromosomes
  - D) the presence of introns
  - E) none of the above
12. Lysine methylation in a histone protein produces a form of chromatin known as \_\_\_\_\_ with the genes being transcriptionally \_\_\_\_\_.
- A) euchromatin; active
  - B) euchromatin; inactive
  - C) heterochromatin; active
  - D) heterochromatin; inactive
  - E) none of the above

13. In prokaryotes, DNA methylation occurs on \_\_\_\_\_ while in eukaryotes, methylation occurs on \_\_\_\_\_.
- A) adenine; thymine
  - B) adenine; cytosine
  - C) guanine; adenine
  - D) guanine; thymine
  - E) guanine; cytosine
14. What is the causative agent in the formation of a cyclobutane thymine dimer?
- A) benzo[a]pyrene
  - B) *N*-methyl-*N*'nitro-*N*-nitrosoguanidine
  - C) methylnitrosourea
  - D) ethylmethanesulfonate
  - E) ultraviolet radiation
15. Methylation of guanine to produce O<sup>6</sup>-methylguanine (mG) results in what change to DNA?
- A) mG frequently pairs with thymine resulting in a GC → AT mutation
  - B) mG loses its methoxy group resulting in hydrogen bonding with adenine and a bulge in the double helix
  - C) mG is prone to deamination and eventually, depurination
  - D) repair of mG adducts uses a radical mechanism that has the potential to further damage adjacent bases, particularly thymine
  - E) none of the above
16. Which of the following types of DNA repair is often coupled with transcription?
- A) photoreactivation
  - B) base excision repair
  - C) replication
  - D) nucleotide excision repair
  - E) all of the above
17. Together with \_\_\_\_\_, \_\_\_\_\_ provide(s) for genetic variability within species and, ultimately, the evolution of new species.
- A) DNA repair; DNA glycosylase
  - B) DNA glycosylase; recombination
  - C) recombination; mutations
  - D) mutations; DNA glycosylase
  - E) DNA repair; mutations
18. Nitrous acid causes the oxidative deamination of cytosine producing uracil. What point mutation is the logical result?
- A) C-G to A-T, only
  - B) C-G to T-A, only
  - C) C-G to G-C, only
  - D) both A and B are correct
  - E) A, B and C are correct

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二、問答題 (64%)：分數標示於各題，請於試卷內之「非選擇題作答區」標明題號依序作答。

1. Where are enhancer sequences found in the gene? (2%)
2. Give the mRNA sequence that would result from the following sense strand: (2%)  
  
5'-A-T-C-T-C-G-A-T-C-G-T-A-C-G-A-T-G-T-C-A-3'
3. What are microRNAs and what role do they play in gene regulation? (4%)
4. Describe the significant differences between eukaryotic and prokaryotic transcription and translation. (6%)
5. (1) How is the DNA unwound at the replication fork? (4%)  
(2) What effect does this have on the DNA upstream of the fork, and how does the cell deal with this effect? (4%)
6. (1) Explain why the replication machinery is incapable of completely replicating the ends of the chromosomes. What is the practical effect of this? (5%)  
(2) How do eukaryotic cells get around this problem? (5%)
7. Describe two ways by which DNA polymerase ensures that the correct base is added to the growing polynucleotide chain during replication. (10%)
8. What is the Shine-Dalgarno sequence? What is its role during translation? (8%)
9. (1) What is "mRNA codon"? (3%)  
(2) What is the sequence of the tRNA anticodon that recognizes the mRNA codon 5'-ACG-3'? (2%)  
(3) Describe the significance of the sequence 5'-CCA-3' at the 3' terminus of every tRNA. (3%)
10. Name one technique which can be used to examine the DNA-protein interaction and briefly explain the principle of the method. (6%)

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