

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

一、請選一正確答案，每題 2 分（共 30 分）

1. The nucleoside adenosine exists in a protonated form with a  $pK_a$  of 3.8. The percentage of the protonated form at pH 4.8 is closest to

- (A) 1
- (B) 9
- (C) 50
- (D) 91
- (E) 99

2. Proline disrupts  $\alpha$ -helical structure in proteins because it is

- (A) an acidic amino acid
- (B) an aromatic amino acid
- (C) an imino acid
- (D) a basic amino acid
- (E) a sulfur-containing amino acid

3. The  $K_m$  (*Michaelis* constant) of an enzyme for a substrate is defined operationally as

- (A) the substrate concentration at which the reaction rate is half maximal
- (B) half the substrate concentration at which the reaction rate is maximal
- (C) the dissociation constant of the enzyme-substrate complex
- (D) the dissociation constant of the enzyme-product complex
- (E) the rate constant of the reaction at saturation

4. If the genetic code consisted of four bases per codon rather than three, the maximum number of unique amino acids that could be encoded would be

- (A) 16
- (B) 64
- (C) 128
- (D) 256
- (E) 512

5. In *E. coli*, the inability of the lac repressor to bind an inducer would result in

- (A) constitutive synthesis of  $\beta$ -galactosidase
- (B) inducible synthesis of  $\beta$ -galactosidase
- (C) synthesis of inactive  $\beta$ -galactosidase
- (D) no substantial synthesis of  $\beta$ -galactosidase

6. The first metabolic intermediate that is common to the aerobic metabolism of glucose and fatty acids is

- (A) citrate
- (B) pyruvate
- (C) acetyl CoA
- (D) beta-hydroxybutyrate
- (E) glyceraldehyde 3-phosphate

7. The enzyme reverse transcriptase is useful in the generation of cDNA libraries for which of the following reason?

- (A) It is sensitive to high temperatures and so can be readily “killed” by heat treatment when the reaction is completed.
- (B) It doesn't require a primer to initiate polymerization as do most DNA polymerases.
- (C) It is insensitive to high temperatures and so can survive the many cycles of heating required to perform the polymerase chain reaction.
- (D) It is an RNA-dependent DNA polymerase.
- (E) It lacks the proofreading function of most DNA polymerases and so is able to utilize mRNA from mutated genes as a template.

8. All of the following statements are true about damage by ultraviolet light to DNA in living cells EXCEPT:

- (A) The damage blocks normal DNA replication
- (B) Covalent bonds are formed that join neighboring pyrimidines.
- (C) Neighboring phosphodiester bonds are cleaved.
- (D) The most damaging wavelength is about 260 nm.
- (E) Most cells can synthesize proteins capable of repairing UV damage.

9. A silent mutation in a gene results in

- (A) no change in the nucleotide sequence if the mRNA encoded by the gene
- (B) no change in the amino acid sequence of the protein encoded by the gene
- (C) no expression of the protein encoded by the gene
- (D) an amino acid substitution that has a significant effect on the functional activity of the protein encoded by the gene.
- (E) a shift of the translational reading frame

10. The nuclear-synthesized poly-A sequence at the 3' end of eukaryotic messenger RNA is

- (A) transcribed by RNA polymerase II

- (B) found also as a common feature in rRNA and tRNA
- (C) transcribed from poly-T sequences in template DNA
- (D) attached a random sequences within the 3' non-translated region of a pre-mRNA
- (E) added after 3' end cleavage of the pre-mRNA transcript

11. The GAL4 protein activates transcription from the *GAL1* promoter in yeast. To bind to DNA, the protein utilizes a

- (A) heme group
- (B) transcriptional-activating domain
- (C) zinc-finger domain
- (D) transmembrane segment
- (E) signal peptide

12. In vertebrate genes, transcription regulatory regions that contain CpG islands are inactivated by which CpG modification

- (A) Acetylation
- (B) Methylation
- (C) Myristylation
- (D) Ubiquitination
- (E) Phosphorylation

13. Retroviral oncogenes are probably aberrant forms of normal cellular genes that regulate cell proliferation. Which of the following gene products are LEAST likely to be encoded by an oncogene

- (A) Capsid proteins
- (B) Tyrosine kinases
- (C) DNA-binding proteins
- (D) GTP-binding proteins
- (E) Transmembrane proteins

14. Active transposable elements have which of the following features?

- I. Repeated sequences at the ends of the transposable element
- II. Different numbers and chromosomal positions in different species of a single genus
- III. The ability to alter the phenotype of an organism

- (A) I only
- (B) II only
- (C) I and II only
- (D) I and III only

(E) I, II, and III

15. A major advantage of monoclonal antibodies compared to polyclonal antibodies is that monoclonal antibodies

- (A) have higher-affinity binding to antigens
- (B) cross-link molecules that share antigenic sites
- (C) have identical binding sites that recognize a specific epitope
- (D) are more easily coupled with probes such as fluorescent dyes
- (E) can be produced against proteins that are immunogenic in rabbits

## 二、問答題 (共 70 分)

1. Describe the sequential steps of protein translation in bacteria (10 分)
2. Compare the differences between the leading and lagging strand DNA replication in bacteria (10 分)
3. Describe the regulatory mechanism of lac operon (8 分) and its second layer of control by catabolite repression (6 分)
4. What is CRISPR/Cas9 system and how it works? (10 分)
5. Describe the regulation of transferring mRNA stability by intracellular iron level. (6 分)
6. Describe the biogenesis and functions of microRNA (8 分)
7. What are noncoding RNAs and how they work? (8 分)
8. Describe the definition of "Precision Medicine". List possible applications of molecular biology in precision medicine. (4 分)