

# 國立中正大學

## 111 學年度碩士班招生考試

# 試題

[第 2 節]

科目名稱	生物化學
系所組別	生物醫學科學系生物醫學

### —作答注意事項—

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始 40 分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

**A. Multiple choice question (50%, 2% each; one correct answer only)**

1. Of the 20 standard amino acids, only \_\_\_\_\_ is not optically active.  
The reason is that its side chain \_\_\_\_\_.  
(A) Alanine; is a simple methyl group.  
(B) glycine; is unbranched.  
(C) lysine; contains only nitrogen.  
(D) glycine; is a hydrogen atom.
2. Thr and/or Leu residues tend to disrupt an  $\alpha$  helix when they occur next to each other in a protein because:  
(A) an amino acid like Thr is highly hydrophobic.  
(B) covalent interactions may occur between the Thr side chains.  
(C) steric hindrance occurs between the bulky Thr side chains.  
(D) the R group of Thr can form a hydrogen bond.  
(E) electrostatic repulsion occurs between the Thr side chains.
3. An  $\alpha$  helix would be destabilized most by:  
(A) the presence of two Lys residues near the amino terminus of the  $\alpha$  helix.  
(B) interactions between neighboring Asp and Arg residues.  
(C) interactions between two adjacent hydrophobic Val residues.  
(D) the presence of an Arg residue near the carboxyl terminus of the  $\alpha$  helix.  
(E) an electric dipole spanning several peptide bonds throughout the  $\alpha$  helix.
4. A sequence of amino acids in a certain protein is found to be -Ser-Gly-Pro-Gly-. The sequence is most probably part of a(n):  
(A) antiparallel  $\beta$  sheet.  
(B) parallel  $\beta$  sheet.  
(C)  $\alpha$  helix.  
(D)  $\alpha$  sheet.  
(E)  $\beta$  turn.
5. Which of the following statements about aromatic amino acids is correct?  
(A) All are strongly hydrophilic.  
(B) Histidine's ring structure results in its being categorized as aromatic or basic, depending on pH.  
(C) On a molar basis, tryptophan absorbs more ultraviolet light than tyrosine.  
(D) The major contribution to the characteristic absorption of light at 280 nm by proteins is the phenylalanine R group.  
(E) The presence of a ring structure in its R group determines whether or not an amino acid is aromatic.

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6. In a mixture of the five proteins listed below, which should elute second in size-exclusion (gel-filtration) chromatography?

- (A) cytochrome *c*  $M_r = 13,000$
- (B) immunoglobulin G  $M_r = 145,000$
- (C) ribonuclease A  $M_r = 13,700$
- (D) RNA polymerase  $M_r = 450,000$
- (E) serum albumin  $M_r = 68,500$

7. The interactions of ligands with proteins:

- (A) are relatively nonspecific.
- (B) are relatively rare in biological systems.
- (C) are usually irreversible.
- (D) are usually transient.
- (E) usually result in the inactivation of the proteins

8. When oxygen binds to a heme-containing protein, the two open coordination bonds of  $Fe^{2+}$  are occupied by:

- (A) one O atom and one amino acid atom.
- (B) one  $O_2$  molecule and one amino acid atom.
- (C) one  $O_2$  molecule and one heme atom.
- (D) two O atoms.
- (E) two  $O_2$  molecules.

9. A monoclonal antibody differs from a polyclonal antibody in that monoclonal antibodies:

- (A) are labeled with chemicals that can be visualized.
- (B) are produced by cells from the same organism that produced the antigen.
- (C) are synthesized by a population of identical, or "cloned," cells.
- (D) are synthesized only in living organisms.
- (E) have only a single polypeptide chain that can recognize an antigen.

10. Enzymes are potent catalysts because they:

- (A) are consumed in the reactions they catalyze.
- (B) are very specific and can prevent the conversion of products back to substrates.
- (C) drive reactions to completion while other catalysts drive reactions to equilibrium.
- (D) increase the equilibrium constants for the reactions they catalyze.
- (E) lower the activation energy for the reactions they catalyze.

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11. Which of the following statements about a plot of  $V_0$  vs.  $[S]$  for an enzyme that follows Michaelis-Menten kinetics is *false*?
- (A) As  $[S]$  increases, the initial velocity of reaction  $V_0$  also increases.
  - (B) At very high  $[S]$ , the velocity curve becomes a horizontal line that intersects the y-axis at  $K_m$ .
  - (C)  $K_m$  is the  $[S]$  at which  $V_0 = 1/2 V_{max}$ .
  - (D) The shape of the curve is a hyperbola.
  - (E) The y-axis is a rate term with units of  $\mu\text{m/min}$ .
12. Enzyme X exhibits maximum activity at  $\text{pH} = 6.9$ . X shows a fairly sharp decrease in its activity when the  $\text{pH}$  goes much lower than 6.4. One likely interpretation of this  $\text{pH}$  activity is that:
- (A) a Glu residue on the enzyme is involved in the reaction.
  - (B) a His residue on the enzyme is involved in the reaction.
  - (C) the enzyme has a metallic cofactor.
  - (D) the enzyme is found in gastric secretions.
  - (E) the reaction relies on specific acid-base catalysis.
13. Which of the following has not been shown to play a role in determining the specificity of protein kinases?
- (A) Disulfide bonds near the phosphorylation site
  - (B) Primary sequence at phosphorylation site
  - (C) Protein quaternary structure
  - (D) Protein tertiary structure
  - (E) Residues near the phosphorylation site
14. In comparison with DNA-DNA double helices, the stability of DNA-RNA and RNA-RNA helices is:
- (A) DNA-DNA > DNA-RNA > RNA-RNA.
  - (B) DNA-DNA > RNA-RNA > DNA-RNA.
  - (C) RNA-DNA > RNA-RNA > DNA-DNA.
  - (D) RNA-RNA > DNA-DNA > DNA-RNA.
  - (E) RNA-RNA > DNA-RNA > DNA-DNA.
15. In double-stranded DNA:
- (A) only a right-handed helix is possible.
  - (B) sequences rich in A-T base pairs are denatured less readily than those rich in G-C pairs.
  - (C) the sequence of bases has no effect on the overall structure.
  - (D) the two strands are parallel.
  - (E) the two strands have complementary sequences.

16. The double helix of DNA in the B-form is stabilized by:

- (A) covalent bonds between the 3' end of one strand and the 5' end of the other.
- (B) hydrogen bonding between the phosphate groups of two side-by-side strands.
- (C) hydrogen bonds between the riboses of each strand.
- (D) nonspecific base-stacking interaction between two adjacent bases in the same strand.
- (E) ribose interactions with the planar base pairs.

17. Which of the following statements is *not* true concerning glycolysis in anaerobic muscle?

- (A) Fructose 1,6-bisphosphatase is one of the enzymes of the pathway.
- (B) It is an endergonic process.
- (C) It results in net synthesis of ATP.
- (D) It results in synthesis of NADH.
- (E) Its rate is slowed by a high [ATP]/[ADP] ratio.

18. All of the following are considered "weak" interactions in proteins, except :

- (A) hydrogen bonds
- (B) hydrophobic interactions
- (C) ionic bonds
- (D) peptide bonds
- (E) van der Waals forces

19. When a mixture of glucose 6-phosphate and fructose 6-phosphate is incubated with the enzyme phosphohexose isomerase, the final mixture contains twice as much glucose 6-phosphate as fructose 6-phosphate. Which one of the following statements is most nearly correct, when applied to the reaction below ( $R = 8.315 \text{ J/mol}\cdot\text{K}$  and  $T = 298 \text{ K}$ )?

Glucose 6-phosphate  $\leftrightarrow$  fructose 6-phosphate

- (A)  $\Delta G^\circ$  is  $+1.7 \text{ kJ/mol}$ .
- (B)  $\Delta G^\circ$  is  $-1.7 \text{ kJ/mol}$ .
- (C)  $\Delta G^\circ$  is incalculably large and negative.
- (D)  $\Delta G^\circ$  is incalculably large and positive.
- (E)  $\Delta G^\circ$  is zero.

20. In the  $\alpha$  helix the hydrogen bonds:

- (A) are roughly parallel to the axis of the helix.
- (B) are roughly perpendicular to the axis of the helix.
- (C) occur mainly between electronegative atoms of the R groups.
- (D) occur only between some of the amino acids of the helix.
- (E) occur only near the amino and carboxyl termini of the helix.

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21. In glycoproteins, the carbohydrate moiety is always attached through the amino acid residues:
- (A) asparagine, serine, or threonine.
  - (B) aspartate or glutamate.
  - (C) glutamine or arginine.
  - (D) glycine, alanine, or aspartate.
  - (E) tryptophan, aspartate, or cysteine.
22. In the binding of oxygen to myoglobin, the relationship between the concentration of oxygen and the fraction of binding sites occupied can best be described as:
- (A) hyperbolic.
  - (B) linear with a negative slope.
  - (C) linear with a positive slope.
  - (D) random.
  - (E) sigmoidal.
23. The predominant structural feature in myosin molecules is:
- (A) a  $\beta$  structure.
  - (B) an  $\alpha$  helix.
  - (C) the Fab domain.
  - (D) the light chain.
  - (E) the meromyosin domain.
24. Which of the following statements about protein-ligand binding is correct?
- (A) The  $K_a$  is equal to the concentration of ligand when all of the binding sites are occupied.
  - (B) The  $K_a$  is independent of such conditions as salt concentration and pH.
  - (C) The larger the  $K_a$  (association constant), the weaker the affinity.
  - (D) The larger the  $K_a$ , the faster is the binding.
  - (E) The larger the  $K_a$ , the smaller the  $K_d$  (dissociation constant).
25. The biological role of restriction enzymes is to:
- (A) aid recombinant DNA research.
  - (B) degrade foreign DNA that enters a bacterium.
  - (C) make bacteria resistant to antibiotics.
  - (D) restrict the damage to DNA by ultraviolet light.
  - (E) restrict the size of DNA in certain bacteria.

**B. Essay (50%)**

1. Show how NADH is recycled to  $\text{NAD}^+$  under anaerobic conditions in mammals. (2%) Why is it important to recycle NADH produced during glycolysis to  $\text{NAD}^+$ ? (3%)
2. List the five coenzymes that are required for the oxidative decarboxylation of pyruvate. (5%)
3. Explain why the mammals cannot convert acetyl-CoA to glucose. (5%)
4. Describe the mechanism for transportation of fatty acid from the cytosol to mitochondria for  $\beta$ -oxidation. (5%)
5. Ketone bodies will be built up in the fasting mice. Why? (5%)
6. Draw the structure of the following molecules.
  - (a) succinate (1%)
  - (b)  $\alpha$ -ketoglutarate (1%)
  - (c) lactate (1%)
  - (d) citrate (1%)
7. Indicate the subcellular location for the following lipid metabolisms in mammals:
  - (a) Fatty acid synthesis (1%)
  - (b) Fatty acid elongation (1%)
  - (c) Fatty acid desaturation (1%)
  - (d) Phospholipids synthesis (1%)
  - (e) Ketone body synthesis (1%)
  - (f)  $\beta$ -oxidation (1%)
8. Glutamate is an important neurotransmitter whose levels must be carefully regulated in the brain. Explain how a high concentration of ammonia might disrupt this regulation and depletion of ATP. (4%) How might a high concentration of ammonia alter the citric acid cycle? (2%)
9. Give two major routes for production of NADPH in mammals. (4%)
10. Describe the chemiosmotic model proposed by Peter Mitchell for ATP synthesis in oxidative phosphorylation. (3%)
11. Explain why compounds such as dinitrophenol (DNP) increase metabolic rates. (2%)