

國立成功大學
110學年度碩士班招生考試試題

編 號： 269

系 所： 生物化學暨分子生物學研究所

科 目： 生物化學

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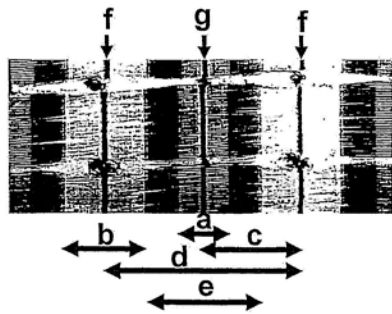
節 次： 第 1 節

備 註： 不可使用計算機

※ 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、選擇題 (共 4 題，每題 2 分)

1. Which of the followings about the sarcomere are true?



1. a: H zone, containing only thick filaments; e: A band, equals to the length of one thick filament.
2. d: a sarcomere unit responsible for muscle contraction.
3. f: Z disks bundling thin filaments in two consecutive sarcomere units.
4. g: M disks bundling both thick and thin filaments.
5. b, c, d, and e: the lengths are all altered upon muscle contraction.

- A. 1, 2
- B. 2, 3
- C. 1, 2, 3
- D. 3, 4, 5
- E. 2, 4, 5

2. Which of the followings about hemoglobin (Hb) are not true?

1. Hb behaves like a dimer of $\alpha\beta$ dimers. There is a 15° rotation of $\alpha_1\beta_1$ with respect to $\alpha_2\beta_2$ upon switching from the T to R state.
2. A new intersubunit β_2 H146-mediated charge-charge interaction formed under lower pH leads to more noncovalent intrasubunit interactions that stabilize T state of Hb.
3. When O_2 binds, it pulls the Fe^{2+} ion into the plane of the heme, causing steric strain between the flattened heme and the proximal His (F8) and Val FG5. Val FG5 is at the corner between F and G helices. This strain is relieved by a change in the orientations of both His F8 and Val FG5.
4. In the case of hemoglobin, O_2 is a *positive* homotropic allosteric effector but CO_2 and 2,3-BPG are

negative heterotropic allosteric effectors, leading to the Bohr effect.

5. Higher affinity of fetal Hb with S143H for O₂ and acute mountain sickness are due to the alterations of 2,3-BPG-binding in the T state of Hb.
- A. 2, 4, 5
B. 1, 2, 3
C. 2, 3, 4
D. 1, 4, 5
E. 1, 3, 4, 5
3. Which of the followings about thin filament-associated proteins are true?
1. One actin filament can be wound around by two right-handed strands of tropomyosins in which 1 tropomyosin binds to 7 consecutive actin subunits and tropomyosins bind to each other head to tail within each strand of tropomyosins.
 2. A tropomyosin molecule contains two right-handed α helices to form a right-handed coiled coil structure.
 3. In the absence of Ca⁺⁺ ions, all of myosin head binding sites in the thin filaments are blocked by troponins, which contain three different subunits.
 4. Tropomyosins are removed from myosin head binding sites in the thin filaments directly by the troponin TnI subunit upon 4 Ca⁺⁺ ions binding to TnC.
 5. The muscles in a dead animal are extremely tight and stiffened due to the release of Ca⁺⁺ ions from the sarcoplasmic reticuli into cytosols without the production of ATPs, making thick filaments tightly stuck up on thin filaments.
- A. 3, 4
B. 2, 5
C. 2, 4
D. 1, 3
E. 1, 5
4. Which of the followings about antibody are true?
1. The high binding specificity of antibodies make them ideal for delivering drugs to specific locations in the body of a cancer patient. A linker connecting an antibody and a drug is very stable and resistant to an enzymatic cleavage in the circulation until the antibody-drug complexes are endocytosed in the acidic endosomes/lysosomes by tumor cells.
 2. Both IgM and IgA contain monomers, dimers, trimers, tetramers, and pentamers of Y-shaped molecules arranged around a central J subunit.

3. Antibody-antigen interactions are mediated by shape and charge complementarity. The antigen binding site is hypervariable and comprises the complementarity-determining regions of the antibody amino acid sequence located at the ends of the antibody.
 4. Initial exposure to an antigen stimulates the B lymphocytes to proliferate and form memory cells, which mount a larger response upon subsequent exposure to the antigen, and plasma cells, which secrete a soluble form of the antigen-specific antibody.
 5. The immunoglobulin fold is a β -sandwich made of two β antiparallel sheets stacked face to face. This motif occurs 4 times in a Fc-free fragment after an antibody molecule is digested by pepsin.
- A. 1, 5
B. 2, 3
C. 2, 4
D. 1, 4
E. 3, 5

二、問答題與簡答題（共 11 題，共計 92 分）

5. Please describe the biological functions/significances of the pentose phosphate pathway. (10%)
6. Please describe the major control points of the glycolysis pathway, and how these enzymes are regulated. (10%)
7. Please describe the major control points of the citric acid cycle, and how these enzymes are regulated. (10%)
8. Please describe the chemiosmotic theory, proposed by Peter Mitchell, in ATP synthesis. (10%)
9. Pernicious anemia is a deficiency in red blood cells caused by lack of vitamin B12 in the blood. What are the causes and consequences of vitamin B12 deficiency in humans? (10%)
10. In addition to dietary restriction (DR) without malnutrition, methionine is found to be able to mimic the effects of DR to extend lifespan in various model organisms. Please explain from one-carbon metabolism, epigenetics, and protein translation points of view to discuss why methionine restriction can slow aging to increase longevity. (10%)
11. 5-Fluorouracil (5-FU) is a chemotherapeutic prodrug commonly used for the treatment of solid cancers. Please explain: (1) the meaning of "prodrug" (1%) and (2) the mechanism of action of 5-FU (4%).

12. Adenosine deaminase (ADA) deficiency leads to severe immunodeficiency disease in which T cells and B cells do not develop properly. Please explain the function of ADA (2%) and the potential disease mechanism of ADA-mediated severe immunodeficiency disease (3%) from nucleotide metabolism point of view.
13. Phenylketonuria (commonly known as PKU) is an inherited disorder that increases the levels of an amino acid, phenylalanine, in the blood. Please describe the disease mechanism of PKU from phenylalanine metabolism point of view. (5%)
14. In three tubes each containing 25 mmole of enzyme A dissolved in 100 ml of an appropriate buffer (pH 7.4), 4 mM, 10 mM, or 30 mM of the specific substrate (molecular weight =100 dalton) could be converted into 0.1 mmole, 20 mg, or 2 mM, respectively, of products per second. For this catalytic reaction: What are the V_{max} (mmole/sec) (3%); K_m (mM) (3%); and the K_3 (sec^{-1}) (3%)?
15. Please write down the key words best defined by each description of the followings:
Note: Don't exceed three words in each description!
 - A. The randomness or disorder of the components of a chemical system (2%)
 - B. A type of macromolecules combining with lipids to form several classes of lipoprotein particles, spherical complexes with hydrophobic lipids in the core and hydrophilic amino acid side chains at the surface. (2%)
 - C. The type of processing reactions altering some newly made proteins, both prokaryotic and eukaryotic, to attain their final biologically active conformations. (2%)
 - D. The effect of pH and CO_2 concentration on the binding and release of oxygen by hemoglobin. (2%)