國立成功大學 109 學年度碩士班招生考試試題

系　　所：生物化學暨分子生物學研究所、臨床藥學與藥物科技研究所

考試科目：生物化學　　考試日期：0211，節次：1

※ 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（5 分，每題 1 分）

1. Which of the following is considered as macromolecule?
   A. Amino acid
   B. Fatty acid
   C. Nucleic acid
   D. Lipoic acid
   E. Chlorophyll

2. Energy requiring metabolic pathways that yield complex molecules from simpler precursors are:
   A. amphibolic.
   B. endergonic
   C. autotrophic.
   D. catabolic.
   E. exergonic.

3. Which of the following is *not* correct concerning cooperative binding of a ligand to a protein?
   A. It is usually a form of allosteric interaction.
   B. It is usually associated with proteins with multiple subunits.
   C. It rarely occurs in enzymes.
   D. It results in a nonlinear Hill Plot.
   E. It results in a sigmoidal binding curve.

4. Which of the following is *not* correct concerning 2,3-bisphosphoglycerate (BPG)?
   A. It binds at a distance from the heme groups of hemoglobin.
   B. It binds with higher affinity to fetal hemoglobin than to adult hemoglobin.
   C. It stabilizes the T state of hemoglobin for oxygen.
   D. It is an allosteric modulator.
   E. It is normally found associated with the hemoglobin extracted from red blood cells.

5. The Myoglobin and the subunits of hemoglobin have:
   A. no obvious structural relationship but very similar Hill coefficient upon oxygen binding.
   B. Very similar Hill coefficient upon oxygen binding, but different primary and tertiary structures.
   C. very similar primary structures and similar Hill coefficient upon oxygen binding, but different tertiary structures.
   D. very similar primary and tertiary structures, but different Hill coefficient upon oxygen binding.
   E. very similar tertiary structures, but different primary structures and different Hill coefficient upon oxygen binding.

二、選擇題（20 分，每題 2 分）

6. Which of the followings about myoglobin (Mb) and hemoglobin (Hb) are true?

1. Both tetrameric Hb and monomeric Mb bind O_2, but only Hb releases O_2
2. Hb and Mb are built on a common protein folding motif
3. Mb, about 2 mg/kg of human muscle tissue, for efficient delivery of O_2 to mitochondria
4. Deep-diving mammals have 10-30-fold more Mb; this capacity for oxygen storage permits long periods underwater between breaths
5. Both Mb and 4 subunits of Hb are all α helix structure

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

7. Which of the followings about myoglobin (Mb) and hemoglobin (Hb) are true?

1. In heme, ferric is bound to protoporphyrin IX
2. Ferric has six coordinating positions, four of these are N's of heme, one is O_2, and the sixth is the proximal histidine residue of the globin protein
3. A porphyrin is a conjugated tetrapyrrole ring system
4. The heme responsible for O_2 binding is a prosthetic group of Mb and Hb
5. As more O_2 binds to ferric-containing Hb, the visible spectrum shifts from the blue spectrum to the red spectrum

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

8. Which of the followings about affinities of myoglobin (Mb) and hemoglobin (Hb) for O_2 binding are not true?

1. At P_{O2} of 30 mm Hg, both Mb and Hb would be >90% saturated with O_2
2. $[Mb][O_2]/[MbO_2]$ equals to P_{O2} at half saturation
3. $[Hb]/[Hb]+[HbO_2]$ of Hb with a low O_2 affinity at the same $[O_2]$ is higher than that with a high O_2 affinity

4. If Hb, exhibiting herperbolic O_2 binding curve, were a strong O_2-binding transport protein, it would have been efficient in unloading but inefficient in binding O_2
5. A Hb exhibits a sigmoidal binding curve, leading to an O_2–independent switch between higher and lower affinity states efficient in both O_2 binding and unloading

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

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

1. Hb behaves like a dimer of αβ 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 β2 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 O_2 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

10. 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.

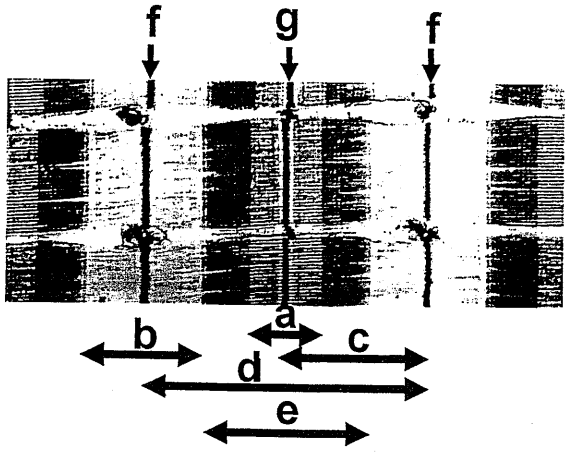
A. 1, 5
B. 2, 3
C. 2, 4
D. 1, 4
E. 3, 5

11. Which of the followings about the hierarchical sequence of muscle are true?

1. One myofibril contains many M disk-connected sarcomeres.
2. A fascicle is a bundle of many myofibers that contain many myofibrils.
3. An individual muscle fiber contains many thin filaments and thick filaments bundled with sarcoplasmic reticuli.
4. A bundle of myofibrils build up a sarcomere that contains many thin and thick filaments.
5. Blood vessels surround muscle cells to provide sufficient oxygen and necessary nutrients.

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

12. 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 think 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

13. Which of the followings about the myosin are not true?

1. It is a molecule composed of 2 heavy chains with right-handed coiled coil structure at the C-terminal ends and globular domains at N-terminal ends, each associated with two light chains.
2. The two light chains are called essential and regulatory light chains.
3. Two S1 fragments are produced by a papain digestion from two heavy meromyosin.
4. Two C-terminal supercoiled myosin heavy chains are right-handed α helices.
5. Helical arrangement and association of myosins are bundled and connected tail to tail at the bare zone with associated proteins as M disk in the sarcomere unit.

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

14. Which of the followings about the muscle contraction are not true?

1. Ca^{++} ions that are released from sarcoplasmic reticuli initiate muscle contraction by binding to myosin heads to force an energy-independent conformational change, rendering strong binding between thin and thick filaments.
2. ATP binds to myosin heads to release them from actin filaments upon ATP hydrolysis.
3. Actin-binding sites on myosin heads won't be proximal to next actin until ATP hydrolysis, driving myosin heads "cock".
4. ATP hydrolysis followed by ADP releasing from and Pi remaining on myosin heads forces a power stroke of myosin heads to make strong bindings between myosin heads and actins.
5. The power stroke of myosin heads is caused by a drastic energy-dependent conformational change and a strong retraction to pull thin filaments toward M disks.

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

15. 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

三、簡答題（75 分）

16. Please describe "the Pasteur effect" in glycolysis regulation. (5%)

17. What is the committed enzyme and major control point for glycolysis? How it is regulated by fructose-2,6-bisphosphate (F2,6-BP). (5%)

18. What are the major biological functions of the pentose phosphate pathway? (5%)

19. What are the five cofactors of the pyruvate dehydrogenase complex? (5%)

20. Please describe the two anabolic reactions that can produce amino acid in the citric acid cycle. (5%)

21. What are the major control points/enzymes for the citric acid cycle? (5%)

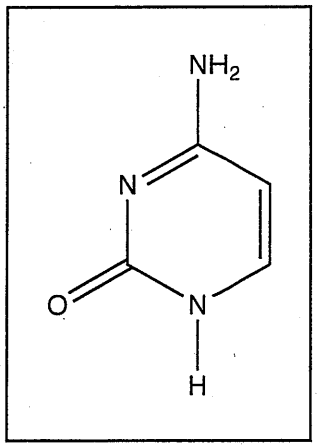
22. 2,4-dinitrophenol (DNP) is an uncoupling reagent. Please describe the effects of DNP to mitochondria. (5%)

23. Please describe "the P/O ratio". (5%)

24. Please describe how Vitamin D3 is synthesized in skin cells. (5%)

25. What is the committed enzyme and major control point for fatty acid synthesis? Name the two protein kinases can control this enzyme by phosphorylation? (5%)

26. This is a nucleobase structure. Please REDRAW the structure on your answer sheet and answer the following questions. (5%)



a. What is the name of this nucleobase?
b. Give the name and the one letter abbreviation of the base cytosine base-pairs (H-bonds) with in DNA?
c. Indicate by **circle** on **your drawing** through which atom cytosine is connected to ribose or deoxyribose.
d. What is the name of the molecule composed of cytosine linked to ribose?
e. Indicate by **triangle** on **your drawing** which groups on cytosine are involved in base-pairing (H-bonding) with its complementary base.

27. Lesch-Nyhan syndrome shows symptoms of crippling and gouty arthritis due to excessive uric acid, a purine degradation product, accumulation. Please describe the potential disease mechanism of Lesch-Nyhan syndrome from the nucleotide metabolism point of view. (5%)

28. About 80% of the excreted waste nitrogen is in the form of urea which is critical to maintain cellular homeostasis. Please describe the reactions of urea cycle and indicate the locations (either in cytosol or in mitochondria) of the reactions. (10%)

29. Tetrahydrofolate (THF) carries activated one carbon units for biosynthesis. Please write down the four amino acids and one tRNA that are directly involved in the THF-mediated one carbon transfer processes. (5%)