

注意：考試開始鈴響前，不得翻閱試題，  
並不得書寫、畫記、作答。


國立清華大學 114 學年度碩士班考試入學試題

系所班組別：生命科學暨醫學院  
甲組(生物與醫學科學組)

科目代碼：0401

考試科目：生物化學

### —作答注意事項—

1. 請核對答案卷(卡)上之准考證號、科目名稱是否正確。
2. 考試開始後，請於作答前先翻閱整份試題，是否有污損或試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清(含未依範例畫記)致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「國立清華大學試場規則及違規處理辦法」，無法因本試題封面作答注意事項中未列明而稱未知悉。

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\*請在【答案卡】作答

**Part 1** 選擇題，20 題單選題 (每題 1 分，共 20 分)，答錯不倒扣

1. Which of the following reaction would favor cellular gluconeogenesis in the fasted state?  
(A) Acetyl-CoA activates pyruvate carboxylase.  
(B) Fructose 2,6-bisphosphate activates pyruvate kinase.  
(C) AMP activates phosphofructokinase 1.  
(D)  $\text{NAD}^+$  activates glyceraldehyde 3-phosphate dehydrogenase.  
(E) None of the above.
2. Which of the following urine component can be used as a biomarker to monitor DNA turnover?  
(A) beta-alanine.  
(B) ammonium ion  
(C) beta-aminoisobutyrate.  
(D) cytidine.  
(E) AMP
3. Which of the following enzyme is not located in mitochondria?  
(A) carbamoyl-phosphate synthase 1  
(B) voltage-dependent anion channel  
(C) carnitine transporter  
(D) DNA polymerase gamma  
(E) carbamoyl-phosphate synthase 2
4. Which inhibitor can be used to inhibit complex III of electron transport chain in cells?  
(A) cyanide  
(B) oligomycin  
(C) rotenone  
(D) malonate  
(E) none of the above

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5. Which of the following best describes the relationship between glucose and fructose?
  - (A) Epimers
  - (B) Structural isomers
  - (C) Enantiomers
  - (D) Diastereomers
  - (E) *Cis-trans* isomers
6. What important reducing agent is an important product of the pentose phosphate pathway?
  - (A) NADH
  - (B) NADPH
  - (C) NADP<sup>+</sup>
  - (D) NAD<sup>+</sup>
  - (E) DTT
7. Which glycolytic reaction cannot be directly reversed in gluconeogenesis?
  - (A) glucose converted into glucose-6-phosphate
  - (B) glucose-6-phosphate converted into fructose-6-phosphate
  - (C) 3-phosphoglycerate converted into 1,3-bisphosphoglycerate
  - (D) 1,3-bisphosphoglycerate converted into glyceraldehyde-3-phosphate
  - (E) phosphoenolpyruvate converted into 2-phosphoglycerate
8. Which of the following is catalyzed by an oxidoreductase in Krebs cycle?
  - (A) oxaloacetate > citrate
  - (B) isocitric acid >  $\alpha$ -ketoglutaric acid
  - (C) fumarate > malate
  - (D) citric acid > isocitric acid
  - (E) citric acid > *cis*-aconitate
9. Why is single-stranded RNA (ssRNA) chemically less stable than single-stranded DNA (ssDNA)?
  - (A) ssRNA has a more rigid structure than ssDNA.
  - (B) because Uridine is less stable than thymidine

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\*請在【答案卡】作答

- (C) ssDNA is more flexible than ssRNA.
  - (D) ssRNA has stronger base stacking interactions than ssDNA.
  - (E) ssRNA contains an additional hydroxyl group that makes it more reactive.
10. Which amino acid is the most flexible in protein structures?
- (A) Alanine
  - (B) Leucine
  - (C) Proline
  - (D) Serine
  - (E) Glycine
11. Flippases are enzymes that flip:
- (A) fatty acids from one site on glycerol to another.
  - (B) glucose from its alpha- to beta-configuration.
  - (C) amino acids between different positions within a protein.
  - (D) cholesterol between different organelles.
  - (E) phospholipids to the opposite side of a membrane.
12. How many chiral carbons are present in an aldopentose?
- (A) 1      (B) 2      (C) 3      (D) 4      (E) 5
13. Aminotransferases are enzymes that have all of the following characteristics except:
- (A) Can make a  $\alpha$ -keto acid from an  $\alpha$ -amino acid
  - (B) use pyridoxal phosphate as a carrier of amino acid
  - (C) catalyze highly reversible reactions
  - (D) Use ATP
  - (E) Serum levels are used as a clinical measure of tissue damage
14. Pyruvate can be converted to glucose via gluconeogenesis or oxidized to acetyl-CoA.
- (A) In the conversion of pyruvate to glucose, the first enzyme pyruvate carboxylase is allosterically inhibited by acetyl-CoA.

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\*請在【答案卡】作答

- (B) In the conversion of pyruvate to glucose, the first enzyme pyruvate dehydrogenase is allosterically inhibited by acetyl-CoA.
  - (C) Pyruvate is oxidized to acetyl-CoA by pyruvate dehydrogenase complex, which is allosterically inhibited by acetyl-CoA.
  - (D) Pyruvate is oxidized to acetyl-CoA by pyruvate dehydrogenase complex, which is allosterically activated by acetyl-CoA.
  - (E) None of the above.
15. In the citric acid cycle, all of the following enzymes require  $\text{NAD}^+$  as a coenzyme except the reaction catalyzed by:
- (A) isocitrate dehydrogenase.
  - (B) malate dehydrogenase.
  - (C)  $\alpha$ -Ketoglutarate dehydrogenase.
  - (D) succinate dehydrogenase.
  - (E) none of the above.
16. HMG-CoA reductase is the key regulatory site in cholesterol synthesis. Which of the following statement about the regulatory mechanisms of HMG-CoA reductase is TRUE?
- (A) HMG-CoA reductase phosphatase can activate HMG-CoA reductase,
  - (B) A high AMP:ATP ratio leads to activation of HMG-CoA reductase,
  - (C) Phosphorylation by cAMP-dependent kinase activates HMG-CoA reductase,
  - (D) High cholesterol level increases the half-life of HMG-CoA reductase,
  - (E) High cholesterol level increases HMG-CoA reductase gene expression.
17. What is the role of transition-state stabilization in enzyme-catalyzed reactions?
- (A) To enhance the thermal stability of the enzyme
  - (B) To increase the binding affinity of the substrate
  - (C) To lower the activation energy, thereby increasing the reaction rate
  - (D) To increase the stability of the product, thereby reducing side reactions
  - (E) To provide reaction versatility

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\*請在【答案卡】作答

18. What is the correct order of these events during muscle contraction?
- a. Calcium ions are released from the sarcoplasmic reticulum
  - b. Hydrolysis of ATP and energy release
  - c. Detachment of myosin from actin
  - d. Power stroke
  - e. Opening of switch 1 and switch 2 on myosin head
- (A) a e b d c    (B) e b c a d    (C) a b c d e    (D) a d e b c    (E) e d c b a
19. Enzyme A can act on substrate S and substrate T and follows simple Michaelis-Menten kinetics. The Michaelis constant  $K_m$  of enzyme A for substrate S is  $K_m^S = 2 \text{ mM}$ , and the rate constant  $k^S$  is  $5 \times 10^3 \text{ sec}^{-1}$ . For substrate T,  $K_m^T = 5 \text{ mM}$ , and  $k^T$  is  $2.5 \times 10^4 \text{ sec}^{-1}$ . Which substrate exhibits greater catalytic efficiency?
- (A) S
  - (B) T
  - (C) Enzyme A uses S and T with the same catalytic efficiency.
  - (D) cannot be determined due to insufficient information.
  - (E) The result would change if the enzyme's conditions or substrate concentrations varied.
20. Hemoglobin exhibits sigmoidal binding kinetics for oxygen. Which of the following terms describes hemoglobin's ability to enhance oxygen binding after the first oxygen molecule binds?
- (A) Allosteric inhibition
  - (B) Competitive inhibition
  - (C) Allosteric activation
  - (D) Cooperativity
  - (E) Catalysis

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Part 2 簡答題 10 題 (每題 8 分，共 80 分)

1. Why do polysaccharides have greater structural diversity compared to polypeptides? (8 points)
2. Which two amino acids are completely positively charged at physiological pH? (8 points)
3. Please describe or illustrate the structure (2 points) of ATP synthase and how this machinery links to the chemiosmotic hypothesis (6 points).
4. Please describe how starch is synthesized in plants (4 points) and how this process is regulated by photosynthesis (4 points).
5. How is the organic sulfide assimilated from sulfate? (8 points)
6. Please compare the carbamoyl-phosphate I and II according to their substrate; intracellular locations; involved pathways; regulators. (8 points)
7. How are eukaryotic transcripts processed and delivered to the ribosomes for translation? (8 points)
8. What is the structure of ribosomes, and how are they assembled? (8 points)
9. Please design a set of oligonucleotide primers (16-mers) of the following short DNA sequence for PCR amplification (5' -> 3'). (8 points)  
TGTGGGAGCTGTGATGATGTTTGTAGGCTTCCTGGGGTGCTATGGGGCCATC  
CAGGAGGTGGCTGCAGGCATCTGGGGCTTCGTAAACAAAGACCAGATCGC  
CAAGGA

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\*請在【答案卷】作答

10. A 12-kb DNA fragment was digested with restriction enzymes HindIII and PstI under the following conditions:

(1) Digestion with HindIII yielded fragments of 3 kb, 4 kb, and 5 kb.

(2) Digestion with PstI yielded fragments of 2 kb, 5 kb, and 5 kb.

(3) Concomitant digestion with both HindIII and PstI yielded fragments of 1 kb, 2 kb, 2 kb, 3 kb, and 4 kb.

Using this data, please construct a possible restriction map of the original 12-kb fragment. (8 points)