

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 111 學年度碩士班考試入學試題


系所班組別：生命科學院

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。

# 國立清華大學 111 學年度碩士班考試入學試題

系所班組別：生命科學院甲組、乙組、丁組

考試科目（代碼）：生物化學(0401、0501、0701)

共 8 頁，第 1 頁

\*請在【答案卡】作答

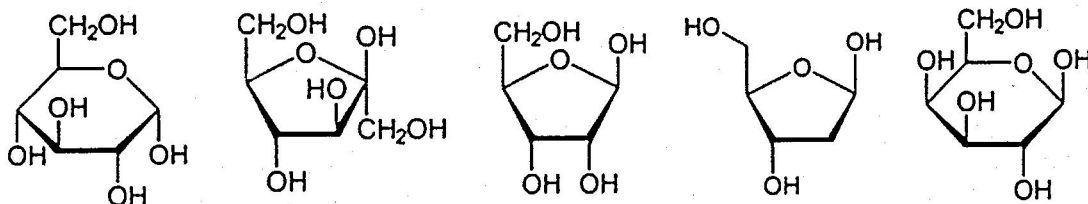
Part 1 單選題 (每題一分，共二十分，答錯不倒扣。請在【答案卡】作答)

1. Which lipid is NOT the major component of biological membranes? (A) cholesterol, (B) phosphatidylcholine, (C) arachidonic acid, (D) choline sphingomyelin, (E) phosphatidylethanolamine.

2. What biomolecule defines human blood types O, A, B, and AB? (A) IgG, (B) Cell surface glycans, (C) Cell surface lipids, (D) mRNA, (E) Extracellular matrix proteins.

3. Which of the following molecule is the building block of DNA?

(A) (B) (C) (D) (E)



4. Which of the following statements about membrane transport is CORRECT?

- (A) Charged molecules can pass through the membrane spontaneously,
- (B) Active transport absolutely requires ATP hydrolysis,
- (C) Conformational changes are not required for active transporters,
- (D) The directionality of transport is determined by the structure of channel proteins,
- (E) Facilitated diffusion can be saturated by substrates.

國立清華大學 111 學年度碩士班考試入學試題

系所班組別：生命科學院甲組、乙組、丁組

考試科目（代碼）：生物化學(0401、0501、0701)

共 8 頁，第 2 頁

\*請在【答案卡】作答

5. Which of the following statement about glycosaminoglycans is INCORRECT?

- (A) They are branched polysaccharides,
- (B) They are components of proteoglycans,
- (C) They tend to be negatively charged,
- (D) They can be found in tendons, cartilage, and other connective tissue,
- (E) They are components of extracellular matrix.

6. Which of the following descriptions about defective urea cycle is wrong?

- (A) The level of ammonia in the blood will decline, causing hypoammonemia,
- (B) Ammonia can enter the brain, inhibiting the TCA cycle and resulting in brain dysfunction,
- (C) this problem may arise because of damage to the liver,
- (D) this problem can be caused by mutations in carbamoyl phosphate synthetase,
- (E) none of the above.

7. Which of the following descriptions about photorespiration is wrong?

- (A) It occurs when  $O_2$  is used in the Calvin-Benson cycle instead of  $CO_2$ ,
- (B)  $C_3$  plants have higher risk of photorespiration than  $C_4$  plants,
- (C)  $C_4$  plants use PEP-carboxylase for initial  $CO_2$  fixation,
- (D) peroxisomes serve important organelles in photorespiration by the conversion of glycine to serine,  $CO_2$ , and  $NH_3$ ,
- (E) none of the above.

國立清華大學 111 學年度碩士班考試入學試題

系所班組別：生命科學院甲組、乙組、丁組

考試科目（代碼）：生物化學(0401、0501、0701)

共 8 頁，第 3 頁

\*請在【答案卡】作答

8. Which of the following descriptions about photosynthesis is wrong?

- (A) In cyclic photophosphorylation, electrons are removed from water and passed through PSII and PSI before ending up in NADPH,
- (B) the electron transfers of the light-dependent reactions are driven by the absorption of energy from light,
- (C) the antenna complex is an array of protein and chlorophyll molecules embedded in the thylakoid membrane,
- (D) the pigment molecules collect energy and transfer it towards the reaction center,
- (E) none of the above.

9. Which of the following descriptions about ATP synthases is wrong?

- (A) They can be found in mitochondria, chloroplast and plasma membrane,
- (B) they account for the irreversible catalysis of ATP to ADP and  $P_i$ ,
- (C) they can be classified as F-, V-, A-, or P-ATPases based on their functional differences,
- (D) the pH gradient acts as a 'battery' to store the electrochemical energy for ATP production,
- (E) none of the above.

10. Which of the following descriptions about starch synthesis is wrong?

- (A) Starch consists of the two glucose polymers, amylopectin and amylose,
- (B) starch is synthesized in the plastids,
- (C) the synthesis of ADP-glucose is often regarded as the "committed step" of starch synthesis,
- (D) starch is a non-structural carbohydrate, composed of glucose polymers linked by  $\beta$ -(1,4)-glycosidic bonds,
- (E) none of the above.



國立清華大學 111 學年度碩士班考試入學試題

系所班組別：生命科學院甲組、乙組、丁組

考試科目（代碼）：生物化學(0401、0501、0701)

共 8 頁，第 4 頁

\*請在【答案卡】作答

11. What would be a result of a high  $[Gln]/[\alpha-KG]$  ratio?

- (A) Increase in deadenylation of glutamine synthetase,
- (B) An increase in activity of glutamine synthetase,
- (C) An increase in the degree of adenylation of glutamine synthetase,
- (D) Inhibition of AT:PIIA and stimulation of AT:PIID,
- (E) A need for ammonium fixation by glutamine synthetase.

12. \_\_\_\_\_ is an intermediate in biosynthesis of ornithine and a regulator of carbamoyl-phosphate synthetase-I.

- (A)  $\gamma$ -Glutamyl-phosphate,
- (B)  $\alpha$ -Ketoglutarate,
- (C) N-Acetylglutamate,
- (D) Glutamine,
- (E) Glutamine-5-phosphate.

13. Elevated levels of homocysteine in the blood is related to all EXCEPT:

- (A) homocysteinuria at very high levels,
- (B) folic acid deficiency,
- (C) folic acid-dependent conversion of homocysteine to methionine,
- (D) higher risk of heart attack and stroke,
- (E) all of the above are correct.

14. All are substrates of carbamoyl phosphate synthetase II (CPS-II) EXCEPT:

- (A)  $H_2O$ ,
- (B)  $NH_4^+$ ,
- (C)  $HCO_3^-$ ,
- (D) glutamine,
- (E) ATP.

國立清華大學 111 學年度碩士班考試入學試題

系所班組別：生命科學院甲組、乙組、丁組

考試科目（代碼）：生物化學(0401、0501、0701)

共 8 頁，第 5 頁

\*請在【答案卡】作答

15. Thymine nucleotides are not synthesized directly by cells but indirectly from other pyrimidine deoxyribonucleotides. All of the following statements regarding thymine nucleotide synthesis are true EXCEPT:

- (A) dUMP is the immediate precursor for dTMP,
- (B) The action of dUTPase allows dUTP to serve as a substrate in DNA synthesis,
- (C) Thymidylate synthase catalyzes the formation of dTMP from dUMP,
- (D) The methyl donor in the reaction of dTMP is N5, N10-methylene-THF,
- (E) THF is used as a cofactor.

16. Which enzymes of the TCA cycle catalyze oxidative decarboxylation reactions?

- (A) isocitrate dehydrogenase and  $\alpha$ -ketoglutarate dehydrogenase,
- (B) fumarase and succinate dehydrogenase,
- (C)  $\alpha$ -ketoglutarate dehydrogenase and succinate dehydrogenase,
- (D) malate dehydrogenase and citrate synthase,
- (E) aconitase and succinate dehydrogenase.

17. Complex I and Complex II produce a common product which is:

- (A)  $\text{NAD}^+$ ,
- (B) FAD,
- (C) reduced cyt c,
- (D) reduced coenzyme Q,
- (E) reduced  $\text{O}_2$ .

國立清華大學 111 學年度碩士班考試入學試題

系所班組別：生命科學院甲組、乙組、丁組

考試科目（代碼）：生物化學(0401、0501、0701)

共 8 頁，第 6 頁

\*請在【答案卡】作答

18. What is another name for complex III:

- (A) cytochrome c oxidase,
- (B) UQ-cytochrome c reductase,
- (C) succinate-UQ reductase,
- (D) NADH-UQ reductase,
- (E) cytochrome bc<sub>1</sub> complex.

19. \_\_\_\_\_ are all derived from 20-carbon fatty acids that are acylated to membrane phospholipids and released by the enzyme \_\_\_\_\_.

- (A) Eicosanoids; phospholipase A<sub>2</sub>,
- (B) Arachidonates; phospholipase A<sub>1</sub>,
- (C) Eicosanoids; phospholipase A<sub>1</sub>,
- (D) Arachidonates; triacylglycerol lipase,
- (E) Arachidonates; phospholipase A<sub>2</sub>.

20. Lipoproteins consist of a core of \_\_\_\_\_ and \_\_\_\_\_ surrounded by a single layer of \_\_\_\_\_, into which is inserted \_\_\_\_\_ and \_\_\_\_\_.

- (A) proteins; triacylglycerols; cholesterol esters; phospholipids; cholesterol,
- (B) triacylglycerols; cholesterol; proteins; cholesterol esters; phospholipids,
- (C) phospholipids; cholesterol esters; triacylglycerols; proteins; cholesterol,
- (D) cholesterol esters; proteins; cholesterol; phospholipids; triacylglycerols,
- (E) triacylglycerols; cholesterol esters; phospholipids; proteins; cholesterol.

國立清華大學 111 學年度碩士班考試入學試題

系所班組別：生命科學院甲組、乙組、丁組

考試科目（代碼）：生物化學(0401、0501、0701)

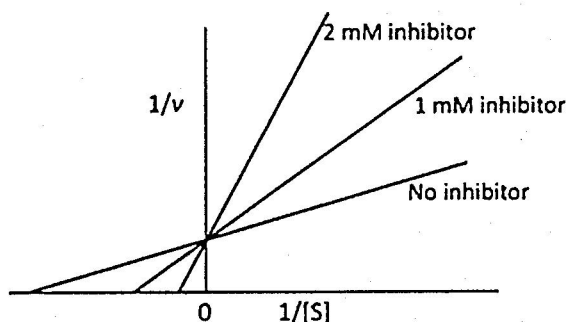
共 8 頁，第 7 頁

\*請在【答案卷】作答

Part 2 問答題（八題，共計八十分。請在【答案卷】務必依序作答）

1. Which two amino acids are linked to sugar in O-linked glycoproteins? (8 %)

2. The figure below is a Lineweaver-Burk plot, showing enzyme activity in the absence and presence of a reversible inhibitor. (a) Based on this plot, what type of enzyme inhibitor is this? (b) Does the  $V_{max}$  change in the presence of inhibitor? (c) Where is the inhibitor binding site? (12%)



3. Ribulose-1,5-bisphosphate carboxylase/oxygenase (Rubisco) is the core autotrophic carboxylase in all oxygenic photosynthetic organisms. Rubisco activase (Rca) adjusts the rate of  $\text{CO}_2$  fixation to the rates of electron transport activity via the reactivation of inhibited Rubisco. Please elaborate how different factors (e.g., ribulose-1,5-bisphosphate,  $\text{CO}_2$ ,  $\text{Mg}^{2+}$ , and ATP) participate in the process before or after reactivation of Rubisco mediated by Rca? (10 %)

4. What is chlorophyll fluorescence (5%)? What are applications of chlorophyll fluorescence (5 %)?

5. What are the major fuel depots in following organs: (a) liver (b) adipose tissue (c) skeletal muscle (in rest) (d) heart muscle (e) brain? (10 %)

6. Illustrate the key points of regulation in the biosynthesis of (a) IMP, (b) AMP & (c) GMP (d) E.coli pyrimidine biosynthesis (e) mammalian pyrimidine biosynthesis? (10 %)

國立清華大學 111 學年度碩士班考試入學試題

系所班組別：生命科學院甲組、乙組、丁組

考試科目（代碼）：生物化學(0401、0501、0701)

共\_\_8\_\_頁，第\_\_8\_\_頁

\*請在【答案卷】作答

7. Explain the effects of each following item on the rates of gluconeogenesis. Do they increase or reduce the gluconeogenesis process? (10%)

- (a) increasing the concentration of tissue fructose-1, 6-biphosphate
- (b) increasing the concentration of tissue Acetyl-CoA
- (c) increasing the concentration of tissue AMP
- (d) increasing the concentration of citrate
- (e) increasing the concentration of blood insulin

8. The following table records the fatty acid composition of *E. coli* cultured in different temperatures. From the table, please explain why *E. coli* need change its fatty acid composition upon the temperature change. (10%)

**TABLE 2.2.** Fatty acid composition of *E. coli* cells cultured at different temperatures<sup>a</sup>

	Percentage of total fatty acids <sup>b</sup>			
	10°C	20°C	30°C	40°C
Myristic acid (14:0)	4	4	4	8
Palmitic acid (16:0)	18	25	29	48
Palmitoleic acid (16:1)	26	24	23	9
Oleic acid (18:1)	38	34	30	12
Hydroxymyristic acid	13	10	10	8
Ratio of unsaturated to saturated <sup>c</sup>	2.9	2.0	1.6	0.38

<sup>a</sup> The values are given in weight percent of total lipid.

<sup>b</sup> The exact fatty acid composition depends not only on growth temperature but on growth stage and growth medium composition.

<sup>c</sup> Ratios calculated as the total percentage of 16:1 plus 18:1 divided by the total percentage of 14:0 plus 16:0. Hydroxymyristic acid was omitted from this calculation.

Source: Data from Marr, A. G., and J. L. Ingraham, Effect of temperature on the composition of fatty acids in *Escherichia coli*. *J Bacteriol.* 1962, 84:1260–1267. Reprinted with permission from Nelson, D. L., and M. M. Cox, *Lehninger Principles of Biochemistry*, 4th ed. New York: W. H. Freeman, 2005.