

國 立 清 華 大 學 命 題 紙

97 學年度\_生命科學院、生命科學院醫學生物科技學程\_系(所)\_甲、乙\_組碩士班入學考試

科目\_生物化學\_科目代碼\_0201、0301、0501\_共\_6\_頁第\_1\_頁 \*請在【答案卷卡】內作答

第一部份單選擇題 (75%), 請填在電腦答案卡, 每題 1.5 分, 共 50 題, 答錯倒扣 0.5 分

1. Even though the building blocks have fairly simple structures, macromolecules are exquisitely organized in their intricate three-dimensional architecture known as:

(A) configuration (B) conformation (C) sequence (D) Lewis structure (E) structural maturation

2. The structural integrity of supramolecular complexes (assemblies) of multiple components are bonded to each other by all of the following forces EXCEPT:

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

3. Thermodynamics does NOT: (A) describe the flow and interchange of heat, energy, and matter. (B) allow the determination of whether a reaction is spontaneous. (C) provide information on the rate of a reaction. (D) consider heat flow and entropy production. (E) consider the effect of concentration on net free energy change of a reaction.

4. Which of the following statements about ATP is NOT TRUE? (A) It is used for short-term energy in the cell. (B) It has two phosphoanhydride bonds. (C) The reason for the large  $-\Delta G^\circ$  values of hydrolysis reactions is due to destabilization of products. (D) ATP is usually complexed with  $Mg^{2+}$ . (E) ATP is a kinetically stable molecule.

5. Thermodynamic parameters (entropy, enthalpy, free energy, and internal energy) are given for an unknown enzyme. Explain which results would be expected for the breaking of hydrogen bonds and the exposure of hydrophobic groups from the interior during the unfolding process of a protein. (A) Entropy change,  $\Delta S$ , is zero (B) Enthalpy change,  $\Delta H$ , is positive (C) The reaction is spontaneous (D) Enthalpy change,  $\Delta H$ , is negative (E) Entropy change,  $\Delta S$ , is positive

6. Using a cation exchange resin, a mixture of four amino acids is separated using an elution gradient of increasing NaCl solution. What would be the correct elution sequence? (A) asp, arg, ser, lys (B) arg, asp, lys, ser (C) lys, arg, asp, ser (D) asp, ser, lys, arg (E) ser, asp, lys, arg

7. Aspartic acid has  $pK_a$ s at 2.0, 4.2 and 10.0. Calculate the isoelectric point for aspartic acid. (A) 6.0 (B) 4.2 (C) 5.4 (D) 7.1 (E) 3.1

8. What is the overall net charge on the peptide Lys-Gly-Ser-Glu-Asp-Arg at pH 7.0? (A) +2; (B) +1; (C) 0; (D) -1; (E) -2

9. The amino acid with a side-chain  $pK_a$  near neutrality and which therefore plays an important role as proton donor and acceptor in many enzyme catalyzed reactions is: (A) histidine (B) cysteine (C) proline (D) serine (E) methionine.

10. A Ramachandran plot shows (A) the amino acid residues which have the greatest degree of rotational freedom. (B) the sterically allowed rotational angles between R groups and  $\alpha$ -carbons in a peptide. (C) the sterically allowed rotational angles between  $C_\alpha$  and the amide nitrogen ( $C_\alpha$ -N) as well as between  $C_\alpha$  and the amide carbonyl carbon ( $C_\alpha$ -CO). (D) the sterically allowed rotational angles about the amide nitrogen (NH) and CO (E) the amino acid residues that form  $\alpha$ -helix,  $\beta$ -sheet, etc.

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科目\_\_生物化學\_ 科目代碼\_\_0201、0301、0501\_\_共\_\_6\_\_頁第\_\_2\_\_頁 \*請在【答案卷卡】內作答

11. Retinal (the light-absorbing pigment in rhodopsin) contains about 20 carbons. It belongs to (A) monoterpenes (B) sesquiterpenes (C) diterpenes (D) triterpenes (E) tetraterpenes.
12. A typical phospholipid can diffuse laterally in a membrane at a linear rate of several microns per second. At that rate, the molecule can travel from one end of a bacterial cell to the other in about (A) 1 msec (B) 10 msec (C) 1 sec (D) 10 sec (E) 1 hour.
13. Which of the following electron transport components is not present in photosystem II of higher plants? (A) Mn (B) ferredoxin (C) plastoquinone (D) pheophytin (E) cytochrome.
14. Valinomycin displays a striking selectivity which is in the sequence (A)  $K^+ > Cs^+ > Na^+$  (B)  $K^+ > Na^+ > Rb^+$  (C)  $Na^+ > K^+ > Rb^+$  (D)  $Rb^+ > Na^+ > K^+$  (E)  $Cs^+ > Li^+ > K^+$ .
15. Lactose intolerance that develops with human age is caused by a deficiency of (A) lactose transporter (B) galactokinase (C) galactose transporter (D) hexokinase (E)  $\beta$ -galactosidase.
16. Which of the following reactions has a standard free energy of hydrolysis more positive than  $ATP \rightarrow ADP$ ? (A) 1,3-bisphosphoglycerate  $\rightarrow$  3-phosphoglycerate (B) creatine phosphate  $\rightarrow$  creatine (C) phosphoenolpyruvate  $\rightarrow$  pyruvate (D) glucose-6-phosphate  $\rightarrow$  glucose (E) 3',5'-cyclic adenosine monophosphate  $\rightarrow$  5'-AMP.
17. The subunit (A)  $\alpha$  (B)  $\beta$  (C) a (D) b (E) c of  $F_1F_0$ -ATP synthase has the highest copy number.
18. Chloride and bicarbonate are transported across the membrane of erythrocyte via (A) simple diffusion (B) facilitated diffusion (C) active transport (D) gap junction (E) specific ionophore.
19. (A) Linolenic acid (B) Myristic acid (C) Palmitic acid (D) Stearic acid (E) Oleic acid has more than one double bond in its long hydrocarbon chain.
20. Azide disrupt energy metabolism by inhibiting (A) the reduction of  $O_2$  by complex IV (B) the oxidation of cytochrome c by complex IV (C) the oxidation of NADH by complex I (D) the oxidation of  $CoQH_2$  by complex III (E) the reduction of cytochrome c by complex III of mitochondria.
21. An enzyme's specificity can be due to: (A) the ratio of catalyzed rate to the uncatalyzed rate of reaction. (B) molecular recognition based on structural complementarity. (C) amount of enzyme produced by the cell. (D) amount of substrate available. (E) metabolic activators.
22. All of the following are properties of a coenzyme EXCEPT: (A) They are usually actively involved in the catalytic reaction of the enzyme. (B) They tend to be stable to heat. (C) They can serve as intermediate carriers of functional groups. (D) They are protein components. (E) They may contain vitamins as part of their structure.
23. What reaction would NOT proceed via bimolecular elementary steps? (A)  $C + D \rightarrow T + U$  (B) A reaction with a rate constant in the units of  $s^{-1}$ . (C)  $2A \rightarrow D + E$  (D) A reaction with a molecularity of 2. (E) A reaction with a rate constant in the units of  $M^{-1}s^{-1}$ .

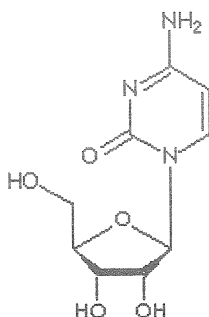
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24. Which of the following statements is NOT characteristic of  $k_{cat}/K_m$ ? (A) It corresponds to a second-order rate constant. (B) It provides an excellent parameter for comparison of the catalytic efficiency of enzymes. (C) It reflects the property of the enzyme when substrate concentration is at saturation. (D) The upper limit for the  $k_{cat}/K_m$  value is fixed by the diffusion-controlled limit for reactions, which is  $10^9 \text{ M}^{-1} \text{ s}^{-1}$ . (E) It is also referred to as the turnover number.
25. The International Units of an enzyme are based on the: (A) ratio of enzyme to other proteins. (B) micromoles of product formed per minute. (C) moles of substrate reacted. (D) micromoles of product produced at  $V_{max}/2$ . (E) none of the above.
26. In transforming the Michaelis-Menten equation into a straight line equation,  $y = mx + b$ , the Lineweaver-Burk double reciprocal plot, which of the following is NOT a true representation? (A) slope =  $K_m/V_{max}$  (B) y-intercept is  $1/V_{max}$  (C) x-intercept is  $1/K_m$  (D)  $y = 1/V$  (E)  $x = 1/[S]$
27. The enzyme-catalyzed reaction rate will be increased if the energy level of ES can be increased by all EXCEPT: (A) destabilization of ES by strain. (B) loss of entropy due to binding of E and S. (C) destabilization of ES by distortion. (D) destabilization of ES by solvation. (E) destabilization of ES by electrostatic effects.
28. Because the  $pK_a$  is near 7, \_\_\_\_\_ side-chains are often involved in general acid-base catalysis. (A) cysteine (B) aspartate (C) glutamate (D) lysine (E) histidine
29. Aspartate proteases display a variety of substrate specificities, but normally they are most active in cleavage of peptide bonds: (A) on the carboxyl side of the basic amino acids. (B) on the carboxyl side of aromatic amino acids. (C) on the carboxyl side of small, neutral residues. (D) between two hydrophobic amino acid residues. (E) none of the above.
30. All are characteristic of allosteric enzymes EXCEPT: (A) Effectors may show stimulatory or inhibitory activity. (B) They have multiple subunits. (C) They obey Michaelis-Menten kinetics. (D) The regulatory effect is by altering conformation and interaction of subunits. (E) Binding one subunit impacts binding of substrate to other subunits.
31. Who was the scientist showed that even though different organisms have different amounts of DNA, the amount of adenine always equals the amount of thymine. (A) Rosalind Franklin. (B) Maurice Wilkins. (C) Linus Pauling. (D) Oswald Avery. (E) Erwin Chargaff.

32.



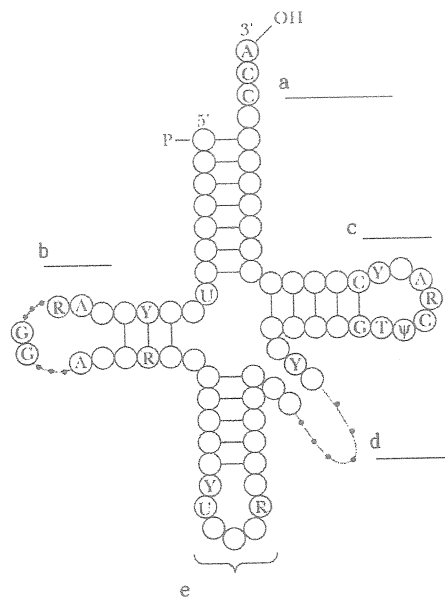
What is this molecule? (A) A. (B) T. (C) G. (D) C. (E) U.

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33. Nucleosomes consist of \_\_\_\_ turns of DNA supercoiled about a histone “core” \_\_\_\_\_. (A) four; pentamer (B) two; octamer (C) four; octamer (D) two; pentamer (E) None of above
34. How to design a “directional cloning”? (A) to create a insert its ends are two blunt ends. (B) to create a insert its ends are two same sticky ends. (C) to create a insert its ends are different sticky ends. (D) to create a insert its ends are one blunt end and one sticky ends. (E) None of above.
35. The base-pair size of plasmid, cosmid, and YACs are  
(A) YACs > plasmid > cosmid. (B) YACs > cosmid > plasmid. (C) plasmid > cosmid > YACs. (D) cosmid > YACs > plasmid. (E) cosmid > YACs > plasmid
36. All are true for DNA polymerase EXCEPT: (A) requires a primer with a free 5'-OH end, but the 3'-end may be phosphorylated. (B) copies the sequence of nucleotides of one strand to form a new second strand. (C) copies the sequence of nucleotides of one strand in a complementary fashion. (D) generates dsDNA from ssDNA (E) synthesizes new strands by adding successive nucleotides in the 5' → 3' direction.
37. The function of DNA topoisomerases is: (A) packaging DNA into nucleosomes. (B) forming cruciform DNA. (C) unwinding G:C rich areas in DNA. (D) breaking one or more strands of DNA, winding them tighter or looser, and rejoining the ends. (E) promoting DNA hybridization.



Give the name of each loop for t-RNA structure: (38-40)

38. The name of the “b” loop is (A) acceptor loop (B). TΨC-loop (C). Variable loop (D). Anticodon loop (E) D-loop
39. The name of the “d” loop is (A) acceptor loop (B). TΨC-loop (C). Variable loop (D). Anticodon loop (E) D-loop
40. The name of the “e” loop is (A) acceptor loop (B). TΨC-loop (C). Variable loop (D). Anticodon loop (E) D-loop

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41. The activation of vitamin B12 requires (A) ATP to covalent bind to cobalt (B) NADH to covalent bind to manganese (C) NADH to covalent bind to magnesium (D) NADPH to covalent bind to copper (E) NADPH to covalent bind to ferrous
42. The Pentose Phosphate Pathway (A) Releases two electrons and produces one NADH (B) Releases two electrons and produces one NADPH (C) Releases four electrons and produces two NADH (D) Releases four electrons and produces two NADPH (E) Releases four electrons and produces one NADH and one NADPH
43. Fatty acid synthesis uses which unit for each stepwise addition? (A) Acetyl-CoA (B) Malonyl-CoA (C) Methylglutaryl-CoA (D) Methylmalonyl-CoA (E) Hydroxybutyryl-CoA
44. Fatty acid desaturation involves (A) Transferring two electrons from NADH to oxygen (B) Transferring two electrons from NADPH to oxygen (C) Transferring four electrons from NADH to oxygen (D) Transferring four electrons from NADPH to oxygen (E) Transferring two electrons from NADH and two electrons from fatty acid to oxygen
45. Fatty acid elongation of two-carbon unit involves (A) Two electrons from NADH (B) Two electrons from NADPH (C) Four electrons from NADH (D) Four electrons from NADPH (E) Two electrons from NADH and two electrons from NADPH
46. Cholesterol biosynthesis involves which of the following addition unit? (A) Acetyl-CoA (B) Melonyl-CoA (C) Isopentenyl pyrophosphate (D) Dimethylallyl pyrophosphate (E) Hydroxybutyryl-CoA
47. The metabolism of odd-chain fatty acids requires which cofactor? (A) B1 (B) B2 (C) B3 (D) B6 (E) B12
48. The common precursors for phospholipids are (A) Glucose and glyceride (B) Phosphatidic acid and diacylglycerol (C) Choline and ethanolamine (D) Dihydroxyacetone and bisphosphoglycerate (E) Carbamoyl phosphate and glutamate
49. The muscle contraction is dependent on (A) Sodium (B) Calcium (C) Copper (D) Ferrous (E) Chloride
50. The nerve conduction is dependent on (A) Sodium and chloride (B) Calcium and chloride (C) Sodium and calcium (D) Sodium and potassium (E) Calcium and potassium

第二部份問答題 (25%)，請寫在答案券，每題 5 分，共 5 題

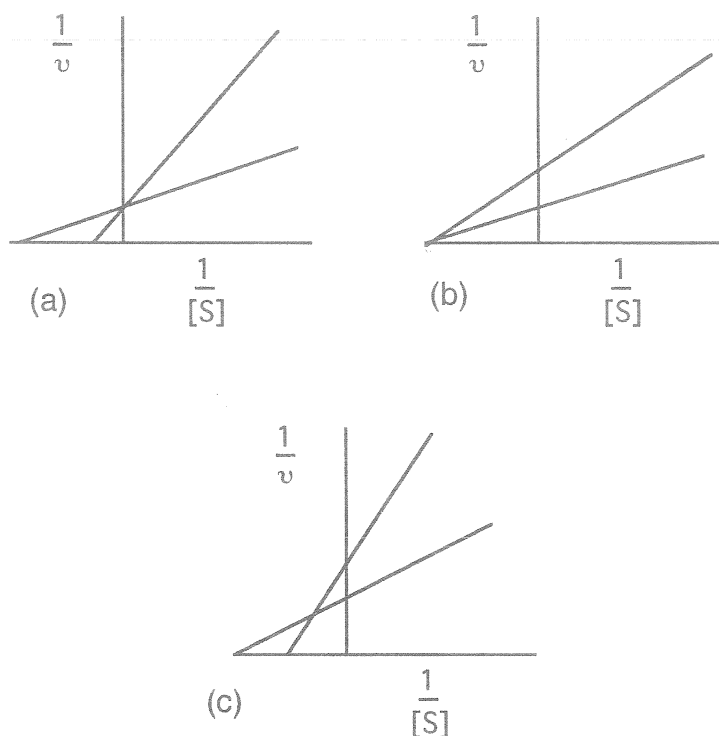
1. Calculate the pH at which the  $\epsilon$ -amino group of lysine is 20% dissociated. ( $\log 2 = 0.3$ ) (5%)
2. Molecular oxygen is reduced by cytochrome c in the complex IV of mitochondria. Write a balanced equation for the reaction and calculate the standard free energy change. (Standard reduction potentials for  $\text{cyt c (Fe}^{3+}) \rightarrow \text{cyt c (Fe}^{2+})$  is +0.254 V and  $\frac{1}{2}\text{O}_2 \rightarrow \text{H}_2\text{O}$  is +0.816 V; Faraday's constant is 96.5 kJ/V) (5%)

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3. The following graphical patterns (a), (b) and (c) obtained from kinetic experiments have several possible interpretations depending on the nature of the experiment and the variables being plotted. Give at least two possibilities for each. (5%)



4. Connect various forms of RNA to its function (5%)

- |          |          |          |           |
|----------|----------|----------|-----------|
| A. tRNA  | B. cRNA  | C. miRNA | D. snoRNA |
| E. siRNA | F. rRNA  | G. snRNA | H. ncRNA  |
| I. mRNA  | J. stRNA |          |           |

- provides the structural and functional foundation for protein synthesis
- disrupts gene expression by blocking specific protein production
- carries the sequence information for synthesis a protein
- carries amino acids to ribosomes for use in protein synthesis

5. Please summarize and explain the biochemical roles of NADH and NADPH based on your answers in questions Part I (第一部份單選擇題) number 42, 44, and 45. (5%)