

科目 生物化學 科號 0801、0901、1001、1101 共 11 頁第 1 頁 \*請在試卷【答案卷】內作答

**Part I: 填充題 (15%, 每題一分. You must write answers with full names in English. No points will be given if the answers are written in abbreviations, words such as DNA, RNA are allowed).**

1. The method or instrument to study the protein coil formation in solution is \_\_\_\_.
2. The method to study the 3D structure of a purified protein, which can grow as a single crystal, is \_\_\_\_.
3. The method to study the 3D structure in solution of a purified protein, which can not grow as a single crystal, is \_\_\_\_.
4. The method or device to determine the approximate molecular weight of a purified protein is \_\_\_\_.
5. The method or instrument to determine the exact molecular weight of a purified protein is \_\_\_\_.
6. The method or instrument to analyze an extremely fast biochemical reaction before it reaches equilibrium is by \_\_\_\_.
7. The method or instrument to determine quantitatively the  $\beta$ -emission by a radioisotope in biological sample is \_\_\_\_.
8. Among the commonly used biologically  $\beta$ -emitting isotopes,  $^3\text{H}$ ,  $^{14}\text{C}$ , and  $^{32}\text{P}$ , which radioisotope has the strongest energy in energy spectrum? \_\_\_\_\_. (答錯倒扣一分)
9. Among the commonly used biologically  $\beta$ -emitting isotopes,  $^3\text{H}$ ,  $^{14}\text{C}$ , and  $^{32}\text{P}$ , which radioisotope has the smallest energy in energy spectrum? \_\_\_\_\_. (答錯倒扣一分)
10. The method or device to amplify an extremely small amount of DNA *in vitro* is \_\_\_\_.
11. The site or location of glycolysis pathway in a cell is \_\_\_\_\_. (答錯倒扣一分)
12. The site or location of fatty acid oxidation in a cell is \_\_\_\_\_. (答錯倒扣一分)
13. The site or location of fatty acid synthesis in a cell is \_\_\_\_\_. (答錯倒扣一分)
14. The major site of citric acid cycle in a cell is \_\_\_\_\_. (答錯倒扣一分)
15. The rate-limiting enzyme in cholesterol synthesis is \_\_\_\_\_.

**Part II: 問答題 (27%)**

1. In a biochemical reaction, the equilibrium constant  $K$  at temperature  $T$  is related to its standard free energy change  $\Delta G^0$  by the following equation:

$$K = \exp(-\Delta G^0/RT). \quad [1]$$

- (a) Start from equation [1]. If you have determined the equilibrium constant  $K$  at different temperature  $T$ , how do you calculate  $\Delta H^0$  and  $\Delta S^0$  for this reaction from your data? (4%)
- (b) Concerning the "R" in the above equation [1], what is the name, the value and unit of R? (1%)
2. Suppose you want to purify a human serum protein X by gel electrophoresis. The estimated molecular weight of this protein is 60 kDa. The concentration of this protein X in blood is in the order of 10  $\mu\text{g/dl}$ . You also know the most abundant human serum protein is albumin with a molecular weight of 66.20 kDa. The concentration of albumin in a normal person is about 4.0 g/dl.
- (a) Based on your knowledge in biochemistry and laboratory experience, design a detail experiment to purify protein X. You must write the names in English and concentrations for all the chemical reagents you use, except for buffer. (4%)
- (b) Continue your gel experiment. After you finish the experiment, show how to calculate the molecular weight of protein X. You must show calculations. (3%)
3. The oxidized coenzyme  $\text{Q}_{10}$  (CoQ) has two keto groups on the 1, 4 positions of its 6-membered ring structure. The reduced  $\text{Q}_{10}$  changes both keto groups to hydroxy groups on the same 1, 4 positions.
- (a) Compare the oxidized and reduced forms, which molecule has more electrons? (2%)
- (b) How many electrons are transferred during the redox reaction of  $\text{Q}_{10}$ ? Show your explanation or calculation. (2%)
- (c) Both vitamins C and E are biological antioxidants. Their structures are shown below. From the structures, explain why vitamin C and E are antioxidants. (2%)
4. What is respiratory control? (4%)
5. What is the reaction center of a photosystem? (5%)

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**Part III: 選擇題 (58%, 每題一分. 每題只有一個正確答案. 請將答案填入答案卡內, 以供電腦閱卷)**

Consider the following three-step conversion



1. What is the equilibrium constant for the overall reaction?  
(a) 10 (b) 1.0 (c) 0.01 (d) 11.1
2. The standard free energy change for overall reaction at 25°C would be  
(a) positive (b) negative (c) zero (d) unpredictable
3. Glycolysis  
(a) requires  $O_2$  to generate energy  
(b) does not require  $O_2$  to generate energy  
(c) is directly inhibited by  $O_2$   
(d) its rate is indirectly increased in the presence of  $O_2$
4. What statement is incorrect about phosphofructokinase (PFK) of the glycolysis pathway?  
(a) Fructose-2,6-bisphosphate is an allosteric inhibitor of PFK  
(b) ATP is an allosteric inhibitor of PFK  
(c) PFK sets the pace of the glycolysis pathway  
(d) PFK activity is influenced by citrate
5. Liver cells in tissue culture can use glutamate as a carbon source. The most likely entry point for glutamate into citrate acid cycle is  
(a) citrate (b) succinate (c) fumarate (d)  $\alpha$ -ketoglutarate
6.  $F_0F_1$ ATP synthase is believed to work as a rotary engine. Which subunit acts as a rotary bearing?  
(a)  $\alpha$  (b)  $\beta$  (c)  $\gamma$  (d)  $\delta$
7. What statement is incorrect about the addition of an uncoupler to mitochondria which are actively oxidizing substrate  
(a) The uncoupler is usually a weak acid  
(b) Less oxygen would be consumed  
(c) The rate of ATP synthesis would be decreased  
(d) The substrate would still be consumed

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8. What statement is incorrect about the addition of an inhibitor such as oligomycin to mitochondria which are actively oxidizing substrate
- (a) Oligomycin binds to  $F_0$  of  $F_0F_1$  ATP synthase
  - (b) Less oxygen would be consumed
  - (c) The rate of ATP synthesis would be decreased
  - (d) The substrate would still be consumed
9. The light reactions of photosynthesis take place in which part of chloroplast?
- (a) thylakoids (b) stroma (c) inner membrane (d) outer membrane
10. What color is the fluorescence of chlorophyll molecules?
- (a) blue (b) yellow (c) green (d) red
11. (a)  $O_2$  (b) NADH (c) ATP (d) NADPH is not a product of the light reactions of higher plant photosynthesis.
12. A molecule is found to be a competitive inhibitor for an enzymatic reaction. Which of the following will characterize the kinetics?
- (a) decrease  $V_{max}$  (b) increase  $V_{max}$  (c) decrease  $K_M$  (d) increase  $K_M$
13. The liposomes prepared often have a large variation in sizes. Many experiments however need liposomes of a uniform size. Which of the following might be the most efficient technique for accomplishing this?
- (a) SDS-PAGE (b) gel permeation chromatography (c) ion exchange chromatography (d) sucrose gradient centrifugation
14. Which technique is commonly used to detect free radicals in a system
- (a) ESR (b) NMR (c) UV-Vis spectrophotometry (d)  $O_2$  electrode
15. Which of the following disaccharides is a non-reducing sugar?
- (a) lactose (b) sucrose (c) maltose (d) cellobiose
16. Which molecule is not a coenzyme of pyruvate dehydrogenase complex?
- (a) Thiamine pyrophosphate (b) lipoic acid (c) biotin (d) coenzyme A
17. When cAMP level rises in liver cells, what event is likely to occur?
- (a) Protein kinase A will be more active
  - (b) Glycogen phosphorylase will be less active

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- (c) Phosphofructokinase will be more active
- (d) Glucose will be stored as glycogen

18. What is the predominant pyrophosphate species in solution at pH 7.0?

(Note)  $pK_1 = 0.85$ ;  $pK_2 = 1.96$ ;  $pK_3 = 6.68$ ;  $pK_4 = 9.39$

- (a)  $H_4P_2O_7$  (b)  $H_3P_2O_7^{-1}$  (c)  $H_2P_2O_7^{-2}$  (d)  $HP_2O_7^{-3}$

19. In the muscle, creatine phosphate is produced by reaction of creatine with ATP.  $\Delta G^0$  of this reaction is 11.7 kJ/mol. How can this reaction occur?

- (a) It is thermodynamically favored under standard condition
- (b) It is kinetically favored, but thermodynamically unfavored under standard condition
- (c) The concentration of ATP is higher than creatine phosphate
- (d) The concentration of creatine is lower than ATP

20. Which of the following molecules is not an antioxidant?

- (a) uric acid (b) fatty acid (c) glutathione (d) ascorbic acid

21.  $CN^-$  is a potent inhibitor of mitochondria. Where is the site of inhibition?

- (a) NADH-CoQ reductase (b) succinate- CoQ reductase (c) CoQ-cytochrome c reductase (d) cytochrome oxidase

22. Which fatty acid has the lowest melting temperature?

- (a) palmitic acid (16:0) (b) stearic acid (18:0) (c) oleic acid (18:1) (d) linoleic acid (18:2)

23. The most abundant RNA in eukaryotic cells is (a) messenger RNA (b) ribosomal RNA (c) transfer RNA (d) small nuclear RNA

24. The reduction potential of a compound is 0 V at pH=0. What is its reduction potential at pH=7? (The temperature is 25°C) (a) 0.42 V (b) 0.32 V (c) -0.42 V (d) -0.32V

25. Which of the following is not a function of mitochondrial  $F_1F_0$  ATP synthase (a) nucleotide binding (b)  $H^+$  conducting (c) ATP hydrolysis (d) ATP translocating

26. Which of the following amino acids is the least water soluble at pH 7.0?

- (a) tryptophan
- (b) glutamic acid

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- (c) cysteine
- (d) histidine

27. If a solution of lysine, valine, and aspartic acid at pH 2 were loaded on a strong cation exchange column and eluted from the column with a gradient of increasing pH, what would be the order (first to last) in which these amino acids would elute from column?

- (a) val, lys, asp.
- (b) lys, val, asp.
- (c) asp, val, lys.
- (d) asp, lys, val.

28. A peptide bond has all these characteristics except:

- (a) the geometry around the amide nitrogen is trigonal planar.
- (b) the H-N-CO bond angle is approximately  $120^\circ$ .
- (c) the N-C  $\alpha$ -R bond angle is approximately  $120^\circ$ .
- (d) the peptide bond is usually in a *trans* configuration.

29. During purification of an enzyme, the purity of the enzyme recovered in various fractions is determined from

- (a) the specific activity in that fraction.
- (b) the total activity in that fraction.
- (c) the activity in that fraction.
- (d) the protein concentration in that fraction.

30. Which statement is incorrect about the reaction of the peptide ser-lys-asp-trp-cys-met-lys-asn-phe-ala with the following reagents?

- (a) Reaction with cyanogen bromide would yields two peptides.
- (b) Reaction with trypsin would result in three peptides. The smallest of the three peptides would have the highest pI of the three.
- (c) Reaction with chymotrypsin would result in the peptides: ser-lys-asp and trp-cys-met-lys-asn-phe-ala.
- (d) Reaction with chymotrysin would yield a different set of peptide that overlap those obtained with trysin.

31. Determine the amino acid sequence of the following oligopeptide from the experimental data below.

- (1) The amino acid composition is found to be [ala, lys, phe, met, cys, plus some decomposed products.
- (2) The peptide has a molecular weight around 700 kDa and absorbs at 280 nm.
- (3) Treatment with carboxypeptidase results in tryptophan and a peptide.
- (4) CNBr treatment yields a tetrapeptide and a dipeptide.

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(5) Trypsin digestion produces an amino acid and a pentapeptide with met on the amino end.

(6) Chymotrysin digestion yields a dipeptide and a tetrapeptide.

(a) trp-lys-met-cys-met-ala.

(b) lys-met-cys-phe-ala-trp.

(c) trp-ala-phe-cys-met-lys.

(d) lys-ala-cys-phe-met-trp.

32. The concentration of the substrate for a specific enzyme in the cell is very often found to be

(a) approximately equal to the  $K_m$  value.

(b) much less than the  $K_m$  value.

(c) much greater than the  $K_m$  value.

(d) equal to or greater than  $k_{cat}/K_m$ .

33. The slowest type of control influencing enzyme activity is

(a) induction.

(b) covalent modification

(c) interaction of an allosteric effector with enzyme.

(d) conformational change in the subunits in an allosteric interaction.

34. The positive effector in hemoglobin is

(a) oxygen molecule

(b) Bisphosphoglycerate

(c)  $\text{CO}_2$

(d)  $\text{H}^+$

35. A characteristic of the heme group in hemoglobin is that it

(a). contains only a porphyrin ring.

(b) contains a porphyrin ring covalently bonded to an Fe(II).

(c) is non-covalently associated with the globin protein.

(d) Contains Fe(III) covalently attached to  $\text{O}_2$ .

36. The covalent binding of para-hydromercuribenzoic acid (pHMB) to the sulhydryl group in ATCase subunits can be reversed by treatment with

(a) high urea concentration

(b) high salt concentration

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- (c) heat
- (d)  $\beta$ -mercaptoethanol

37. For the energy of  $EX^*$  to be lower than that for  $X^*$ , the following must be true.  $K_S$  is the dissociation constant for the ES complex, while  $K_T$  is for the transition state complex.
- (a)  $K_S = K_T$
  - (b)  $K_S > K_T$
  - (c)  $K_S < K_T$
  - (d)  $\Delta G^\circ$  for the reaction must be reduced.
38. The intrinsic binding energy,  $\Delta G_b$ , may stabilize
- (a) the ES intermediate.
  - (b) the transition state complex  $EX^*$ .
  - (c) the EP intermediate.
  - (d) all of these species.
39. Four competitive inhibitors to an enzyme in the glycolytic pathway are studied and are found to exhibit the following  $K_I$  values. Which is the best inhibitor?

Inhibitor	$K_I$ values (M)
A	$1 \times 10^{-2}$
B	$7 \times 10^{-11}$
C	$5 \times 10^{-9}$
D	$3 \times 10^{-5}$

- (a) A
- (b) B
- (c) C
- (d) D

40. The good transition state analog is one which would serve also as an effective
- (a) competitive inhibitor
  - (b) noncompetitive inhibitor
  - (c) allosteric effector
  - (d) uncompetitive inhibitor
41. Covalent catalysis is carried out by enzyme using a
- (a) ping-pong mechanism
  - (b) sequential bisubstrate mechanism



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- (c) random bisubstrate mechanism
  - (d) simple unimolecular mechanism
42. Which of the following statement is incorrect for the proposed mechanism in aspartic protease?
- (a) involves two proton transfers.
  - (b) the initial proton transfer makes an "incipient" hydroxide ion a better attacking group than water.
  - (c) the planar intermediate attacks the protonated aspartic acid.
  - (d) the second proton transfer makes the peptide fragment with newly produced amino end a better leaving group.
43. The enzyme ribonuclease A contains both a protonated histidine and a unprotonated histidine in its active site prior to substrate binding. Which statement is logically correct about the catalytic mechanism of RNase A?
- (a) It shows a sharp pH optimum centered around pH 6.0.
  - (b) The protonated histidine has a lower  $pK_a$  than the unprotonated one.
  - (c) The protonated histidine can act as a general acid catalyst.
  - (d) Two of the above statements are correct.
44. Indicate which of the following is not a characteristic of microtubules.
- (a) They are made up of two repeating subunits.
  - (b) They grow at one end and are degraded at the other end.
  - (c) They are static, helical structure.
  - (d) They are hollow, cylindrical structures.
45. Intracellular axonal transport of vesicles and mitochondria occur through
- (a) flagella
  - (b) microtubules
  - (c) cilia
  - (d) myosin fibrils.
46. The sliding filament model for muscle contraction was primarily proposed by
- (a) A. Szent Gyorgyi
  - (b) S. Ebashi
  - (c) L. Kunkel
  - (d) R. Huxley
47. In *E. coli*, rotation of the flagella is powered by
- (a) phosphorylation of the MotB protein by phosphoenolpyruvate.

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- (b) the hydrolysis of ATP by MotB protein.
  - (c) the hydrolysis of GTP by the flagella.
  - (d) a proton gradient across the plasma membrane of the bacterium.
48. Hormones, such as glucocorticoids, effect their action by
- (a) binding to a plasma membrane receptor and then entering the cell.
  - (b) binding to a plasma receptor, which stimulates the receptor to enter the cell.
  - (c) diffusing into the cell and then binding to a DNA sequence.
  - (d) diffusing into cell, binding to an intracellular receptor and effecting a response.
49. Intracellular second messengers include all the following except for
- (a)  $\text{Ca}^{+2}$
  - (b) Diacylglycerol
  - (c) AMP
  - (d) Nitric oxide
50. G proteins are associated with which receptor superfamily?
- (a) oligomeric ligand-gated ion channels
  - (b) 7-transmembrane segment receptors
  - (c) cell adhesion protein receptor
  - (d) single transmembrane segment catalytic receptor.
51. Calmodulin exhibits all the following characteristics except for
- (a) its conformation is sensitive to  $\text{Ca}^{+2}$  binding.
  - (b) it contains a basic amphiphilic alpha helix which interacts with target proteins.
  - (c) it modulates the activity of many protein kinases.
  - (d) it contains one or more helix-loop-helix motifs (EF-hands) which bind the  $\text{Ca}^{+2}$  ion.
52. Which of the following reactions in the urea cycle hydrolyzes ATP to AMP and  $\text{PP}_i$  to drive the reaction to the right?
- (a) carbamoyl phosphate + ornithine  $\rightarrow$  citrulline +  $\text{P}_i$
  - (b) citrulline + aspartate  $\rightarrow$  arginosuccinate
  - (c) arginosuccinate  $\rightarrow$  arginine + fumarate
  - (d) ammonia +  $\text{CO}_2$  +  $\text{H}_2\text{O}$   $\rightarrow$  carbamoyl phosphate
53. The reaction catalyzed by carbamoyl phosphate synthetase I in mammals
- (a) takes place in the mitochondrial matrix.
  - (b) involves the hydrolysis of 2 ATP.

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- (c) consumes one molecule of ammonia.
- (d) all of the above.

54. Excess nitrogen in organisms can be excreted. A molecule which is not an excreted form of nitrogen is
- (a) urea
  - (b) ammonia.
  - (c) uric acid.
  - (d) arginine.
55. Which of the following statement is incorrect regarding the regulation of *de novo* purine biosynthesis?
- (a) AMP and GMP are allosteric inhibitors of the enzyme that catalyzes the first reaction in the pathway.
  - (b) AMP and GMP are allosteric inhibitors of the enzyme that catalyzes the second reaction in the pathway.
  - (c) GMP is an allosteric inhibitor of the enzyme catalyzing the twelfth reaction in the pathway.
  - (d) Inorganic phosphate is an allosteric activator of the enzyme catalyzing the first reaction in the pathway.
56. The clusters of conserved cysteine residues in the DNA binding domains of hormone receptors suggest that the activity of these receptors may be controlled by
- (a) redox processes.
  - (b) phosphorylation.
  - (c) proteolytic cleavage.
  - (d) binding as dimers.
57. The only coenzyme of which a nucleotide is not a component part is
- (a) Coenzyme A.
  - (b) NADH.
  - (c) Tetrahydrofolate.
  - (d) FAD.
58. What reason best explains why the enzymatic activity of lysozyme is more than ten times slower at pH 7.0 than at pH 5.0?
- (a) A histidine in the active site is not protonated at pH 7.0.
  - (b) The transition state can not be stabilized as effectively.
  - (c) A glutamic acid residues can no longer function as a general acid catalyst at pH 7.0.
  - (d) The enzyme has undergone denaturation at pH 7.0.