

八十八學年度

生命科學系  
生物技術所

系(所) 甲、乙 組碩士班研究生招生考試

科目 生物化學

科號 0701-0801  
1001-1101

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\*請在試卷【答案卷】內作答

I. 單選題 (60%)，每題1.5分

1. To measure the pH of a reaction medium, one has to employ Henderson-Hasselbach equation of
  - a.  $\text{pH} = \text{pK}_a + \log ([\text{HA}]/[\text{A}^-])$
  - b.  $\text{pK}_a = \text{pH} + \log ([\text{HA}]/[\text{A}^-])$
  - c.  $\text{pH} = \text{pK}_a + \log ([\text{A}^-]/[\text{HA}])$
  - d.  $\text{pK}_a = \text{pH} + \log ([\text{A}^-]/[\text{HA}])$
2. Which of the following parameters in the following is the best to describe the tendencies in a biological reaction?
  - a.  $\Delta S$
  - b.  $\Delta E$
  - c.  $\Delta H$
  - d.  $\Delta G'$
  - e.  $\Delta G^0'$
3.  $\Delta G^0'$  for hydrolysis of ATP is -31 kJ/mol, while that for phosphorylation of glucose is +14 kJ/mol. Then,  $\Delta G^0'$  for the phosphorylation of glucose at the expense of ATP is:
  - a. +45 kJ/mol
  - b. -45 kJ/mol
  - c. +17 kJ/mol
  - d. -17 kJ/mol
4.  $\beta$ -emitters are widely used in tracing the pathway of metabolism. Which isotope has highest energy for discriminating window in liquid scintillation counter?
  - a.  $^3\text{H}$
  - b.  $^{14}\text{C}$
  - c.  $^{32}\text{P}$
  - d.  $^{35}\text{S}$
5. Ribonucleotide reductase contains a tyrosine-122 which could form a free radical during reaction. What instrument would you use to observe this phenomenon?
  - a. NMR
  - b. EPR
  - c. IR
  - d. X-ray
6. Which of the following amino acids is *not* classified as a nonpolar amino acid?
  - a. F
  - b. H
  - c. P
  - d. L
  - e. I

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7. Which of the amino acids listed below has more than one chiral carbon?
  - a. T
  - b. C
  - c. H
  - d. W
  - e. A
8. Which of the following atoms are contained in the peptide plane that occurs in a polypeptide?
  - a.  $-C_{\alpha}HRCONHC_{\alpha}HR-$
  - b.  $-C_{\alpha}CONHC_{\alpha}-$
  - c.  $-C_{\alpha}CNC_{\alpha}-$
  - d.  $-C_{\alpha}NH-$
  - e.  $-CONH-$
9. Which of the following interactions is *not* found in the tertiary structure of a protein?
  - a. electrostatic interactions
  - b. hydrophobic interactions
  - c. intermolecular hydrogen bonding
  - d. van der Waals interactions
  - e. disulfide bonds
10.  $\alpha$ -helices are stabilized by which of the following?
  - a. electrostatic interactions
  - b. hydrogen bonding between the R groups
  - c. hydrophobic interactions
  - d. hydrogen bonds between the R groups and the CO in the peptide backbone
  - e. hydrogen bonds between the (CO) and the (NH) units in the peptide backbone
11. The thermodynamics of folding of a soluble protein indicates that the single largest contribution to the stability of a folded protein is
  - a. the conformational entropy change
  - b. the enthalpy change arising from intramolecular side group interaction
  - c. the entropy change arising from the burying of hydrophobic groups within the molecule
  - d. the enthalpy change arising from interactions between solvent molecules and the exposed groups of the molecule
12. Which of the following statements about lipid is *true*?
  - a. Membrane lipids in a lipid bilayer are held together primarily by hydrophobic forces and hydrogen bonds.
  - b. Succinate is an amphipathic molecule.
  - c. The fatty acid that is described as 20:4 is arachidonic acid
  - d. Cholesterol is not amphipathic.
  - e. None of the above.

13. Which of the following characteristics is *not* associated with cellulose?
- It is a linear polymer of glucose.
  - Its glycosidic linkage is  $\beta(1 \rightarrow 4)$ .
  - Hydrolysis of it is accomplished enzymatically by cellulase.
  - Mild acid is effective in its hydrolysis.
  - Human does not have the ability to hydrolyze cellulose.
14. A reaction is known to have a  $\Delta G^\circ$  of  $-3000 \text{ kJ/mol}$ . What can be expected about the kinetics of this reaction?
- It will exhibit very rapid kinetics.
  - It will exhibit very slow kinetics.
  - The kinetics can only be predicted after the reactants and the products in the reaction are known.
  - The kinetics of the reaction cannot be predicted from this information.
15. A synthetic chemist in a well-known pharmaceutical company submits a newly purified compound for testing as an inhibitor for a number of important enzymes in a bacterial metabolic pathway. It was found that this inhibitor can inhibit a particular enzyme (X) activity and increase its  $K_m$  value. Conditions used in the inhibitor studies are outlined below.
- |                                       |  |
|---------------------------------------|--|
| $[\text{Substrate}] = 10 \mu\text{M}$ | $[\text{Inhibitor}] = 100 \mu\text{M}$ |
| $K_m = 1 \times 10^{-6} \text{ M}$    | $K_i = 1 \times 10^{-6} \text{ M}$     |
- What type of inhibitor is it?
- competitive
  - noncompetitive
  - uncompetitive
  - irreversible
  - can not tell from the above information
16. Based on the information of the previous question, calculate the value for  $K_m$  in the presence of the inhibitor (often referred to as the  $K_{app}$ ).
- $1.1 \times 10^{-4} \text{ M}$
  - $9.1 \times 10^{-5} \text{ M}$
  - $1.1 \times 10^{-5} \text{ M}$
  - $9.1 \times 10^{-4} \text{ M}$
  - $1.1 \times 10^{-6} \text{ M}$
17. Which of the following is *not* expected to be a characteristic of a homotetrameric allosteric enzyme?
- it is a multisubunit enzyme
  - it has only one active site per enzyme
  - its effector sites are non-overlapping with the active sites
  - it exhibits sigmoidal kinetic profiles
  - it has distinct conformations

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18. Hormone-receptor complex binds to DNA. To which domain of the receptor, does the hormone bind?
- catalytic domain
  - N-terminus
  - C-terminus
  - None of above
19. Since 2 ATP molecules are produced for each glucose molecule converted to pyruvate, how many ATP molecules are produced from each glucose molecule in glycogen converted to pyruvate? (forget about the NADH molecules)
- one
  - two
  - three
  - six
  - nine
20. Which of the following statement is true for pyruvate kinase?
- it does not catalyze a rate-limiting glycolysis
  - it is not inhibited by ATP
  - it is inhibited by NADH and activated by  $\text{NAD}^+$
  - it is inhibited when the citric acid cycle is in full operation
  - its activity is under hormone control
21. The citric acid cycle ultimately converts what kinds of fuel molecules into biological useful energy?
- carbohydrates only
  - fats only
  - proteins only
  - all of above
  - all of above plus nucleic acids
22. Approximately how many times (folds) more efficient is aerobic metabolism of glucose than anaerobic metabolism of glucose?
- 3
  - 6
  - 12
  - 18
  - 24
23. Which of the following is a mobile component in the electron transport system (chain)?
- cytochrome a
  - cytochrome b
  - cytochrome c
  - cytochrome a
  - cytochrome  $a_3$



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24. The driving force for ATP synthesis during oxidative phosphorylation is
- glucose
  - oxygen
  - proton gradient
  - neutron gradient
  - electrons
25. Depends on different calculations, the P/O ratio for NADH is
- 1.0 or 1.5
  - 1.5 or 2.0
  - 2.0 or 2.5
  - 2.5 or 3.0
  - 3.0 or 3.5
26. Gluconeogenesis occurs in
- the cell membrane
  - the inner mitochondrial membrane
  - the matrix of mitochondria
  - the cytosol
  - the nucleus
27. Which substance blocks the biosynthesis of N-linked glycoproteins?
- CoA
  - dolichol phosphate
  - tunicamycin
  - penicillin
  - cephalosporin
28. Photosystem I
- absorbs monochromatic light at 680 nm
  - oxidizes  $H_2O$ , producing  $O_2$
  - passes excited electrons to photosystem II
  - does not involve in the generation a pH gradient across thylakoid membrane
  - reduces  $NADP^+$  to NADPH
29. In photosynthesis, the dark reactions
- occur in the grana
  - occur in the dark
  - are responsible for the capture of energy
  - produce ATP and NADPH
  - convert  $CO_2$  to carbohydrate

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30. Which of the following transports fatty acids from the cytosol into the mitochondria?
  - a. acylated phosphate
  - b. acylated CoA
  - c. acylated carnitine
  - d. acyl carrier protein
  - e. esterified cholesterol
31. Cholesterol esters
  - a. can get into cells by diffusion
  - b. are transported into cells by carriers
  - c. are transported into cells by membrane fusion
  - d. are actively transported into cells by specific transport proteins
  - e. get into cells by LDL receptor-activated endocytosis
32. The metabolites involved in direct assimilation of  $\text{NH}_3$  are the followings *except*
  - a. carbamoyl phosphate
  - b. aspartate
  - c. asparagine
  - d. glutamate
  - e. glutamine
33. Which is the correct catabolic pathway for purine nucleotide?
  - a. Xanthine  $\rightarrow$  Hypoxanthine  $\rightarrow$  Uric acid
  - b. Hypoxanthine  $\rightarrow$  Xanthine  $\rightarrow$  Uric acid
  - c. Uric acid  $\rightarrow$  Xanthine  $\rightarrow$  Hypoxanthine
  - e. Uric  $\rightarrow$  Hypoxanthine  $\rightarrow$  Xanthine
34. Which experiment proves that DNA replicates semiconservatively?
  - a. Watson-Crick experiment
  - b. Meselson-Stahl experiment
  - c. Avery-MacLeod-McCarty experiment
  - d. Beadle and Tatum experiment
35. A circular, double-strand DNA contains 2100 base pairs. The solution conditions are such that DNA has 10.5 bp/turn. What is approximately  $L_0$  (linking number for DNA in the relaxed state) for this DNA?
  - a. 200
  - b. 300
  - c. 400
  - d. 500
36. The mobility of a polypeptide in SDS-PAGE is
  - a. proportional to its molecular mass
  - b. inversely proportional to its molecular mass
  - c. logarithmically proportional to its molecular mass
  - d. inversely logarithmically proportional to its molecular mass.

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37. Sedimentation coefficient of a protein is
- inversely proportional to its velocity under centrifugation
  - inversely proportional to the square angular velocity of the rotor
  - proportional to frictional coefficient
  - inversely proportional to its molecular mass.
38. Sephadex G-100 is commonly used for the purification of enzymes. Sephadex G-100 is a column for
- cation exchanger
  - anion exchanger
  - affinity chromatography
  - gel filtration.
39. Which of following reagent is used to determine C-terminal residue of a protein?
- ninhydrin
  - Sanger's reagent
  - hydrazine
  - Edman reagent
40. In purification of enzymes,  $\beta$ -mercaptoethanol is routinely used as a(n)
- oxidizing agent
  - reducing agent
  - neutralizing agent
  - chaotropic agent

## 問答題 (40%)

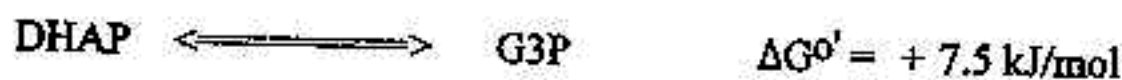
- II. (8%) The protein that you are studying normally has a Glu residue that interacts in a complex with a Lys residue of a second protein A. Another protein, B, differs from A only in having this Lys residue replaced by Glu.
- (1) What will happen when your protein interacts with B. Please draw a related biochemical cartoon using the above information and predict the likely results.
  - (2) You would like to modify your protein by genetic engineering to interact with B instead of A. How would you do? What is the likelihood that replacing the Glu residue with other residue in your protein? Will the engineered protein interact as effectively with protein A? Explain in brief please.
- III. (6%) Outline a general experimental protocol that might be used to fractionate the integral proteins in a cell membrane; then characterize their molecular weights.

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IV. (14%) Please answer the following short questions.

- (1) (6%) In a key reaction of glycolysis, dihydroxyacetone phosphate (DHAP) is isomerized into glyceraldehyde-3-phosphate (G3P):



- Calculate the equilibrium constant, and the equilibrium fraction of G3P from the above, at 37°C.
  - In the cell, depletion of G3P makes the reaction proceed. What will  $\Delta G$  be, if the concentration of G3P is always kept at 1/100 of the concentration of DHAP?
- (2) (4%) Please briefly describe which reaction is carried out by thymidylate synthase and why this enzyme is possibly a target for chemotherapy.
- (3) (4%) Describe a mechanism by which a steroid hormone might act to increase intracellular levels of cyclic AMP.

V. (12%) Scientists commonly employ chemical compounds to elucidate the mechanisms of specific enzymes, specific metabolic pathways, and even cellular functions; sometimes with application purpose. For instance, reverse transcriptase inhibitors and specific protease inhibitors are developed to an anti-HIV drugs. The followings are a list of common inhibitors used in biochemical studies (or as antibiotics/anticancer drugs), please specify their molecular functions. Note: No more than three sentences for each compound.

- Cordycepin (3'-deoxyadenosine)
- Cycloheximide
- Diisopropyl fluorophosphate (DFP)
- Oligomycin
- Penicillin
- Rotenone (and also Amytal)