

國立清華大學命題紙

99 學年度 生醫工程與環境科學系甲組(分子生醫光電組) 碩士班入學考試

科目 生物化學 科目代碼 2302 共 7 頁, 第 1 頁 *請在【答案卷卡】作答

單一選擇題: 25 題, 每題 2 分, 答錯倒扣 0.5 分; 簡答題: 4 題, 共 50 分。

A: 單一選擇題: (*務必使用電腦答案卡作答, 否則不與計分)

- The structure of DNA described by Watson and Crick included
 - a double helix.
 - the sugar phosphate backbone aligned in the center of the helix.
 - the base pairs that are stacked on the inside of the double helix.
 - a and b.
 - a and c.
- Approximately what percentage of the human genome encodes for proteins?
 - 90%
 - 50%
 - 10%
 - 3%
 - 1%
- The energies for hydrogen bonds are approximately
 - 400 kJ/mol.
 - 100–240 kJ/mol.
 - 4–20 kJ/mol.
 - 200 kJ/mol.
 - 100–240 J/mol
- What is the $[A^-]/[HA]$ ratio when the weak acid is in a solution one pH unit above its pK_a ?
 - 1 : 1
 - 1 : 10
 - 10 : 1
 - 2 : 1
 - 1 : 2
- What are the primary chemical components present in a phosphate buffer at pH 7.4?
 - H_3PO_4 and PO_4^{3-}
 - $H_2PO_4^-$ and PO_4^{3-}
 - HPO_4^{2-} and PO_4^{3-}
 - $H_2PO_4^-$ and HPO_4^{2-}
 - H_3PO_4 and HPO_4^{2-}
- Trypsin cleaves the peptide bond at
 - the carboxyl side of Arg and Lys residues.
 - the carboxyl side of Try and Phe residues.
 - the carboxyl side of Met residues.
 - the amino side of Arg and Lys residues.
 - the amino side of Try and Phe residues.

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科目 生物化學 科目代碼 2302 共 7 頁, 第 2 頁 *請在【答案卷卡】作答

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7. Which of the following techniques can be used to determine the site of a disulfide bond?
- (A) Edman degradation (D) MALDI-TOF
(B) affinity chromatography (E) SDS-PAGE
(C) diagonal electrophoresis
8. The sites for intron splicing consensus sequences are often
- (A) AC-----AAAA. (D) AC-----GU.
(B) GU-----AG (E) AU-----GC.
(C) AU-----GC..
9. What do Southern, Northern, and Western blots detect, respectively?
- (A) DNA, RNA, and protein. (D) protein, DNA, and RNA
(B) DNA, protein, and RNA. (E) RNA, protein, and DNA
(C) RNA, DNA, and protein
10. Plasmids used in recombinant DNA technology typically
- (A) possess a gene for antibiotic resistance.
(B) replicate independently of the host genome.
(C) are circular double stranded molecules.
(D) (a) and (b)
(E) (a), (b), and (c)
11. Techniques for engineering new proteins by site-directed gene mutations include:
- (A) oligonucleotide directed mutagenesis. (D) (a) and (b)
(B) cassette mutagenesis. (E) (a), (b), and (c)
(C) chromosome walking mutagenesis.
12. Which of the following statements is correct for hemoglobin and oxygen transport?
- (A) The oxygen binds to the proximal histidine residue of the globin chain
(B) Bonding of carbon dioxide to hemoglobin molecules increases the binding of oxygen.
(C) Hemoglobin binds more oxygen as the pH is lowered.
(D) Hemoglobin binds more oxygen at higher [BPG] concentrations
(E) The binding of each O₂ molecule to hemoglobin increases its affinity for the next O₂.

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科目 生物化學 科目代碼 2302 共 7 頁, 第 3 頁 *請在【答案卷卡】作答

單一選擇題: 25 題, 每題 2 分, 答錯倒扣 0.5 分; 簡答題: 4 題, 共 50 分。

13. What would be the expected result of a Lys residue being substituted with a Ser residue in the BPG binding site of hemoglobin?
- (A) BPG would bind tighter because of the loss of a positive charge.
(B) BPG would bind tighter because of the gain of a positive charge.
(C) BPG would bind less tightly because of the loss of a positive charge.
(D) BPG would bind less tightly because of the gain of a positive charge.
(E) This substitution would have no effect on the binding of BPG
14. Examples of cofactors include
- (A) Zn^{+2} , Mg^{+2} , and Ni^{+2} . (D) (b) and (c).
(B) biotin and thiamine pyrophosphate. (E) (a), (b), and (c).
(C) pyridoxal phosphate and coenzyme A.
15. When the k_{cat} / K_M ratio is at its upper limit, it is referred to as
- (A) Diffusion limits. (D) (a) and (b).
(B) Michaelis rate. (E) (a), (b), and (c).
(C) kinetic perfection.
16. What type(s) of inhibition can be reversed?
- (A) Competitive. (D) (a) and (b)
(B) Noncompetitive. (E) (a), (b), and (c).
(C) Mixed
17. How is specificity determined by chymotrypsin?
- (A) interaction of the active site amino acids with the substrate
(B) binding of the N-terminus amino acid at the active site
(C) covalent binding of a his residue to the substrate
(D) conformational change upon binding of substrate
(E) binding of the proper amino acid into a deep pocket on the enzyme
18. Metal ion catalysis is facilitated by any of several mechanisms, including
- (A) electrophilic activity, which stabilizes negative charges on an intermediate.
(B) promoting formation of nucleophiles by affecting adjacent molecules.
(C) direct binding to substrate, increasing substrate:enzyme contacts.
(D) (a) and (c). (E) (a), (b), and (c).

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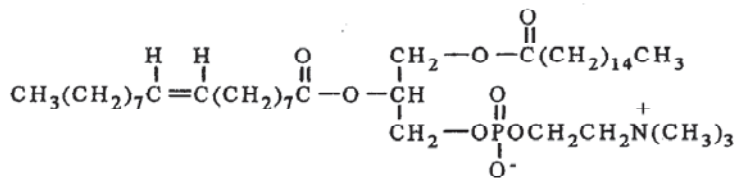
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科目 生物化學 科目代碼 2302 共 7 頁, 第 4 頁 *請在【答案卷卡】作答

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19. Selectins are proteins that
- (A) selectively bind proteins destined for lysosomes.
 (B) aid in selection of proteins bound for the Golgi complex.
 (C) bind immune-system cells as part of the inflammatory response.
 (D) (b) and (c) (E) (a), (b), and (c).
20. Inhibitors against this viral protein have potential as anti-influenza agents.
- (A) Calnexin. (D) Lectin
 (B) Neuramidase. (E) Lysozyme
 (C) Selectin

21. Which of the following is **not** correct concerning the structure given?



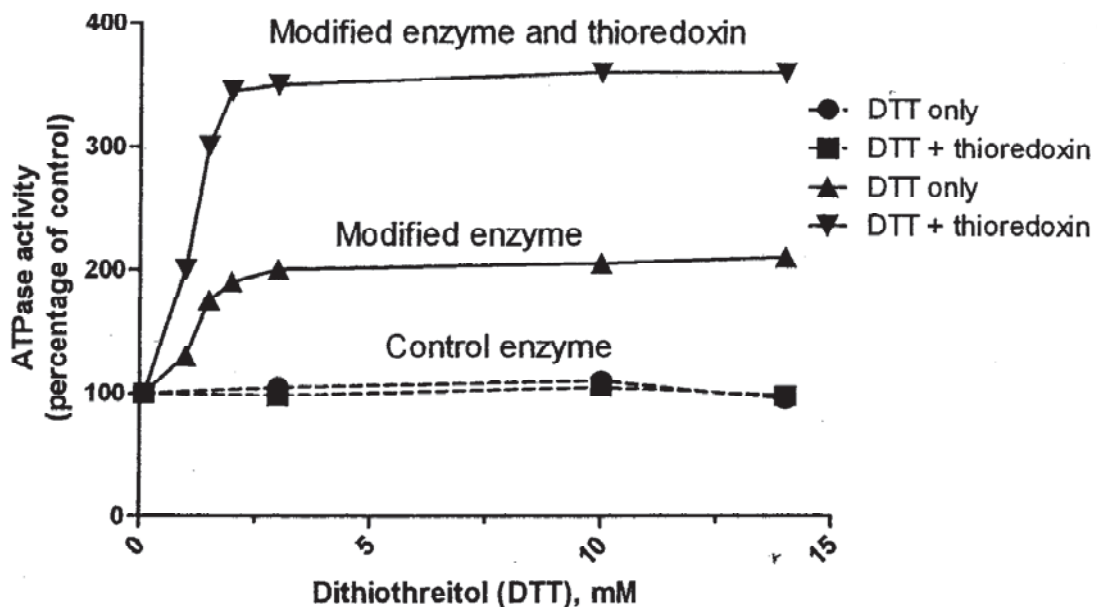
- (A) It is a component of biological membranes.
 (B) It is amphipathic.
 (C) It is a sphingolipid.
 (D) It is a phosphoglyceride.
 (E) It is phosphatidyl choline.
22. Hydrophobic molecules can be covalently attached to proteins to increase membrane association. Type(s) of group(s) include
- (A) palmitoyl groups attached via cys residues.
 (B) glycolipid structures attached to the carboxy terminus.
 (C) farnesyl groups attached via cys residues.
 (D) (a) and (c) (E) (a), (b), and (c).
23. What are the two messenger products formed by cleavage of PIP₂?
- (A) diacylglycerol and inositol 1,4,5-triphosphate
 (B) diacylglycerol and inositol 1,3,5-triphosphate
 (C) diacylglycerol and inositol 1,3-diphosphate
 (D) diacylglycerol phosphate and inositol 1,4,5-trisphosphate
 (E) diacylglycerol phosphate and inositol 1,3,5-trisphosphate

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24. Cross-phosphorylation is possible when two receptor proteins
- (A) are cleaved. (D) (a) and (b)
- (B) dimerize. (E) (a), (b), and (c).
- (C) are internalized into organelles.
25. Fructose can enter glycolysis at two distinct points, depending on the tissue. How is fructose metabolized in adipose tissue?
- (A) Fructose is cleaved to two molecules of GAP.
- (B) Fructose is converted to fructose-1-phosphate.
- (C) Fructose is converted to fructose-6-phosphate.
- (D) Fructose is cleaved to GAP and DHAP.
- (E) Fructose is converted to glucose, which enters the pathway.

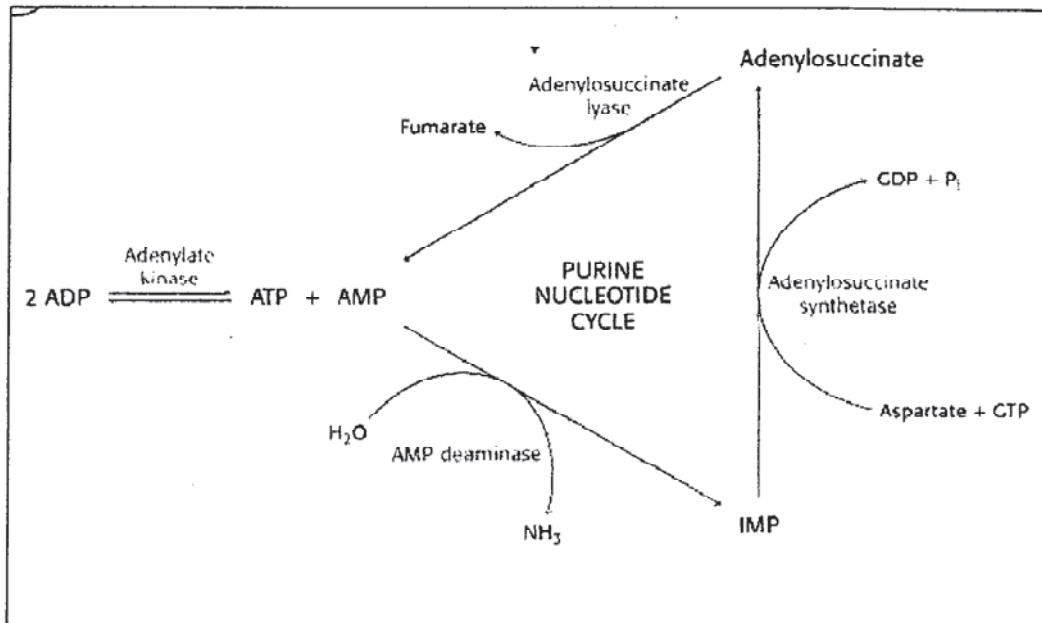
B: 簡答題:

1. The $\alpha_3\beta_3\gamma_3$ complex of mitochondria or chloroplast ATP synthase will function as an ATPase *in vitro*. The chloroplast enzyme (both synthase and ATPase activity) is sensitive to redox control, whereas the mitochondria enzyme is not. To determine where the enzymes differ, a segment of the mitochondria γ subunit was removed and replaced with the equivalent segment from the chloroplast γ subunit. The ATPase activity of the modified enzyme as then measured as a function of redox conditions. (20分)
- (a) What is the redox regulator of the ATP synthase *in vivo*? The adjoining graph shows the ATPase activity of modified and control enzymes under various redox conditions.



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- (b) What is the effect of increasing the reducing power of the reaction mixture for the control and the modified enzymes?
- (c) What is the effect of the addition of thioredoxin? How do these results differ from those in the presence of DTT alone? Suggest a possible explanation for the difference.
- (d) Did the researchers succeed in identifying the region of the γ subunit responsible for redox regulation? Why?
- (e) What is the biological rationale of regulation by high concentrations of reducing agents?
- (f) What amino acids in the γ subunits are most likely affected by the reducing conditions? Why?
- (g) What experiments might confirm your answer to part (e)?
2. Succinate uniformly labeled with ^{14}C is added to cells actively engaged in pyrimidine biosynthesis. Propose a mechanism by which carbon atoms from succinate could be incorporated into a pyrimidine. At what positions is the pyrimidine labeled? (10分)
3. Some interesting reactions as shown in following diagram take place in muscle tissue to facilitate the generation of ATP for contraction. (10分)



In muscle contraction, ATP is converted into ADP. Adenylate kinase converts two molecules of ADP into a molecule of ATP and AMP.

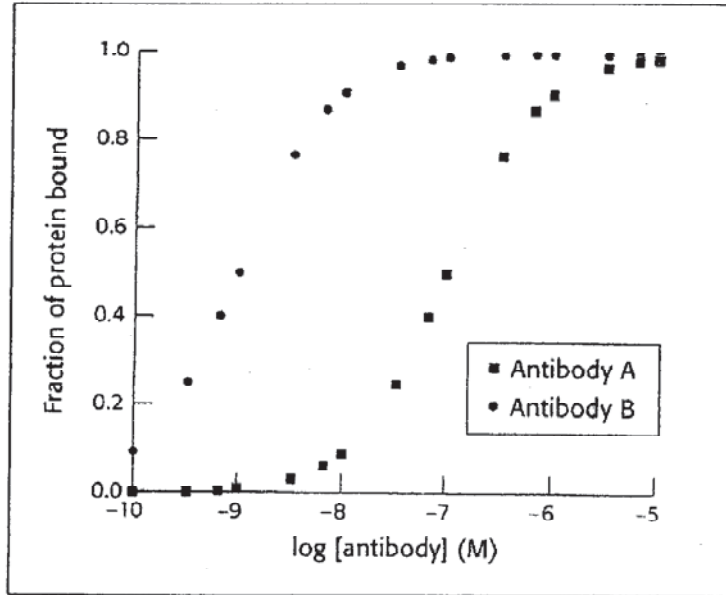
- (a) Why is the reaction beneficial to contracting muscle?
- (b) Why is the equilibrium for the adenylate kinase approximately equal to 1?

Muscle can metabolize AMP by using the purine nucleotide cycle. The initial step in this cycle, catalyzed by AMP deaminase, is the conversion of AMP into IMP.

- (c) Why might the deamination of AMP facilitate ATP formation in muscle?
- (d) How does the purine nucleotide cycle assist the aerobic generation of ATP?

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4. A mouse is immunized with an oligomeric human protein. Shortly after immunization, a cell line that expresses a single type of antibody molecule (antibody A) is derived. The ability of antibody A to bind the human proteins is assayed with the results shown in the graph below. (10分)



After repeated immunizations with the same protein, another cell line is derived that expresses a different antibody (antibody B). The results of analyzing the binding of antibody B to the protein also are shown. From these data, estimate

- The dissociation constant (K_d) for the complex between the protein and antibody A
- The dissociation constant for the complex between the protein and antibody B
- Comparison of the amino acid sequences of antibody A and antibody B reveals them to be identical except for a single amino acid. What does this finding suggest about the mechanism by which the gene encoding antibody B was generated?