

國 立 清 華 大 學 命 題 紙

95 學年度 生醫工程與環境科學 系(所) 甲組(分子生醫光電組) 碩士班入學考試

科目 生物化學 科目代號 3002 共 2 頁 第 1 頁 \*請在【答案卷卡】內作答

簡答題：1-10 題，每題 5 分；11-15 題，每題 10 分。

1. Diagram the biosynthetic pathway from UMP to dTTP. Use abbreviations (e.g., UMP), not complete structures, and indicate where any cofactors participate. (5%)
2. An experimenter studying the oxidation of fatty acids in extracts of liver found that when palmitate (16:0) was provided as substrate, it was completely oxidized to CO<sub>2</sub>. However, when undecanoic acid (11:0) was added as substrate, incomplete oxidation occurred unless he bubbled CO<sub>2</sub> through the reaction mixture. The addition of the protein avidin, which binds tightly to biotin, prevented the complete oxidation of undecanoic acid even in the presence of CO<sub>2</sub>, although it had no effect on palmitate oxidation. Explain these observations in light of what you know of fatty acid oxidation reactions. (5%).
3. Describe the role of the entry of Na<sup>+</sup> and Ca<sup>++</sup> in neuronal signal transduction following acetylcholine binding to its receptor. (5%)
4. How are Holliday junctions resolved during the process of DNA recombination? (5 points).
5. How would the SOS response in *E. coli* be affected by a mutation in the *lexA* gene? (5%)
6. Methionine is one of two amino acids with only one codon. How does the single codon for methionine specify both the initiating residue and interior Met residues of polypeptides synthesized by *E. coli*? (5%)
7. Describe three properties common to the reactions catalyzed by DNA polymerase, RNA polymerase, reverse transcriptase, and RNA replicase. How is the enzyme polynucleotide phosphorylase similar to and different from these enzymes? (5%)
8. One strand of a double-helical DNA has the sequence (5')GCGCAATATTTCTCAAATATTGCGC(3'). What special type of sequence is contained in this DNA segment? Does the single- and double- stranded DNA have the potential to form any alternative structures? (5%)
9. How does a mutation in the *ras* gene that leads to formation of a Ras protein with no GTPase activity affect a cell's response to insulin ? (5%)
10. Isocitrate dehydrogenase is found only in the mitochondrion, but malate dehydrogenase is found in both the cytosol and mitochondrion. What is the role of cytosolic malate dehydrogenase? (5%)

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11. In the first bypass step of gluconeogenesis, the conversion of pyruvate to phosphoenolpyruvate, pyruvate is carboxylated by pyruvate carboxylase to oxaloacetate, which is subsequently decarboxylated by PEP carboxykinase to yield phosphoenolpyruvate. The observation that the addition of  $\text{CO}_2$  is directly followed by the loss of  $\text{CO}_2$  suggests that  $^{14}\text{C}$  of  $^{14}\text{CO}_2$  would not be incorporated into PEP, glucose, or any intermediates in gluconeogenesis. However, when a rat liver preparation synthesizes glucose in the presence of  $^{14}\text{CO}_2$ ,  $^{14}\text{C}$  slowly appears in PEP and eventually at C-3 and C-4 of glucose. How does the  $^{14}\text{C}$  label get into PEP and glucose? (10%)
12. Electron transfer translocates protons from the mitochondrial matrix to the external medium, establishing a pH gradient across the inner membrane (outside more acidic than inside). The tendency of protons to diffuse back into the matrix is the driving force for ATP synthesis by ATP synthase. During oxidative phosphorylation by a suspension of mitochondria in a medium of pH 7.4, the pH of the matrix has been measured as 7.7. (a) Calculate  $[\text{H}^+]$  in the external medium and in the matrix under these conditions. (b) What is the outside-to-inside ratio of  $[\text{H}^+]$ ? Comment on the energy inherent in this concentration difference. (c) Calculate the number of protons in a respiring liver mitochondrion, assuming its inner matrix compartment is a sphere of diameter  $1.5\mu\text{m}$ . (d) From these data, is the pH gradient alone sufficient to generate ATP? (e) If not, suggest how the necessary energy for synthesis of ATP arises. (10%)
13. (a) Describe the difference of the mechanisms for the movement of flagellum in bacteria (*Escherichia coli*) and sperm. (b) Then design an experiment to illustrate it. (10%)
14. Compare the function, distribution, and regulation of following enzymes: (10%)
  - a. Carbamoyl phosphate synthetase I vs carbamoyl phosphate synthetase II
  - b. PFK-I vs PFK-II
  - c. Hexokinase I vs hexokinase II
15. Use epinephrine and  $\beta$ -arrestin as example to explain the phenomena of **“one stimulus triggers two distinct response pathways”** (10%)