

國立清華大學 101 學年度碩士班考試入學試題

系所班組別：生醫工程與環境科學系 甲組（分子生醫工程組）

考試科目（代碼）：生物化學 (~~2022~~)

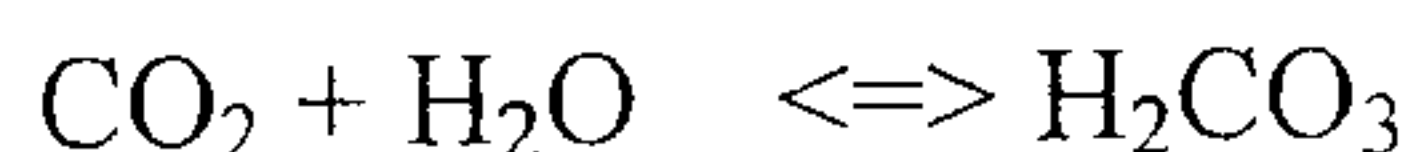
2202

共 3 頁，第 1 頁 *請在【答案卷、卡】作答

1. For an enzyme-catalyzed reaction follows Michaelis-Menten equation, draw Lineweaver-Burk curves that would be obtained when
- twice as much enzyme is used
 - half as much enzyme is used
 - a competitive inhibitor is added
 - a pure noncompetitive inhibitor is added
 - an uncompetitive inhibitor is added

For each example, indicate how V_{\max} and K_m change. (5%)

2. Carbonic anhydrase catalyzes the conversion of hydration of CO_2 . (5%)



The K_m of carbonic anhydrase for CO_2 is 12 mM. When $[\text{CO}_2] = 36$ mM, the rate of the reaction, v , was $4.5 \mu\text{mole mL}^{-1} \text{sec}^{-1}$.

- What is V_{\max} for this enzyme?
- Assuming 5 pmole/ml of enzyme were used in this experiment, what is k_{cat} for this enzyme?
- What is the catalytic efficiency of this enzyme?
- Does this enzyme approach “catalytic perfection”
- What determines the ultimate speed limit of an enzyme-catalyzed reaction? That is, what is it that imposes the physical limit on kinetic perfection?

3. The following DNA fragment was subjected to sequencing by Sanger’s dideoxy method, using fluorescent-tagged dideoxynucleotides and capillary electrophoresis.

5’-----3’-OH

3’-----ATTACGCAAGGACATTAGAC5’

Draw a diagram of the gel-banding pattern within the capillary. (5%)

4. What is a DNA microarray? How does it resemble and how does it differ from a DNA library? (5%)

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5. Briefly describe the biochemical role of the following enzymes in DNA replication in *E. coli*: (5%)
(a) DNA helicase; (b) primase; (c) the 3' → 5' exonuclease activity of DNA polymerase; (d) DNA ligase; (e) topoisomerases;
6. List one basic property that distinguishes RNA polymerases from DNA polymerases, and list one basic property they share. (5%)
7. Define ribozymes and briefly describe the structure and function of two ribozymes. (5%)
8. What is a telomere? Describe the key features of its structure. What is unusual about the structure and/or mechanism of action of telomerase? (5%)
9. If brewer's yeast is mixed with pure sugar (glucose) in the absence of phosphate (P_i), no ethanol is produced. With the addition of a little P_i , ethanol production soon begins. Explain this observation. (5%)
10. Under what circumstances does the bifunctional protein phosphofructokinase-2/fructose 2,6-bisphosphatase (PFK-2/FBPase-2) become phosphorylated, and what are the consequences of its phosphorylation to the glycolytic and gluconeogenic pathways? (5%).
11. CO_2 is produced in two reactions in the citric acid cycle. For each of these reactions, name and show the structures of reactant and product, name the enzyme, and show how any cofactors participate. (5%)
12. Describe the mechanism for moving acetyl-CoA produced in the mitochondrial matrix into the cytosol for fatty acid synthesis. (5%)
13. Show all of the reactions that occur in the pathway from galactose to glycogen in an adult human. You need to give the name of enzymes, the name of intermediates along the path, and show any required cofactors. (10%)

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14. The conversion of glyceraldehyde 3-phosphate to dihydroxyacetone phosphate is catalyzed by triose phosphate isomerase. The standard free-energy change (ΔG°) for this reaction is -7.5 kJ/mol. Draw the two structures. Define the equilibrium constant for the reaction and calculate it using only the data given here. Be sure to show your work. ($R = 8.315$ J/mol·K; $T = 298$ K) (10%)
15. Describe five possible fates for glucose 6-phosphate in the liver. (10%)
16. A scientist wishes to produce a mammalian protein in *E. coli*. The protein is a glycoprotein with a molecular weight of 40,000. Approximately 20% of its mass is polysaccharide. The isolated protein is usually phosphorylated and contains three disulfide bonds. The cloned gene contains no introns. (a) What sequences or sites will be required in the vector to get this gene regulated, transcribed, and translated in *E. coli*? (b) List two problems that might arise in producing a protein identical to that isolated from mammalian cells and describe each problem in no more than two sentences. (10%)