

國立清華大學 102 學年度碩士班考試入學試題

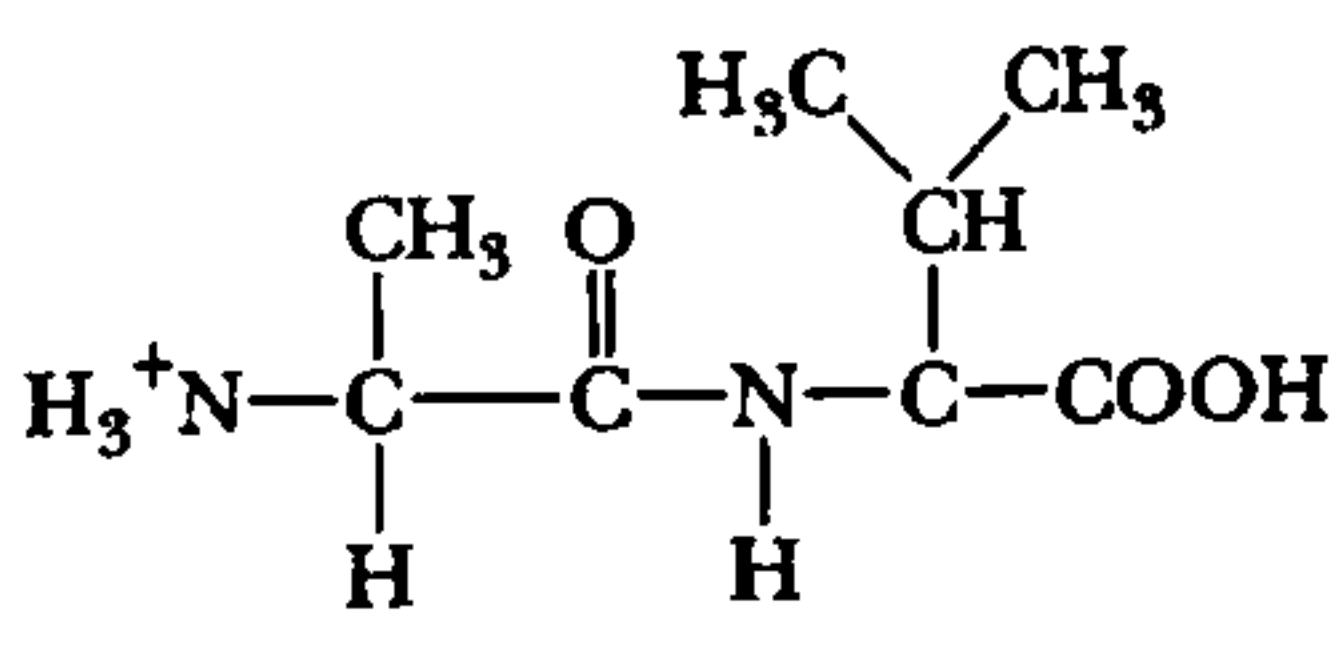
系所班組別：生醫工程與環境科學系 甲組（分子生醫工程組）

考試科目（代碼）：生物化學（2202）

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*請在【答案卷、卡】作答

1. Explain following terms (10 points)
 - (a) dideoxy method
 - (b) primer
 - (c) superhelix density
 - (d) aptamer
 - (e) clone
 - (f) yeast two-hybrid
 - (g) domain
 - (h) hydropathy plot
 - (i) shuttle vector
 - (j) DNA library
2. A 10-kb DNA fragment digested with *Eco*RI yield fragments of 4kb and 6kb in size. When digested with *Bam*HI, fragments 1, 3.5, and 5.5 kb were generated. Concomitant digestion with both *Eco*RI and *Bam*HI yield fragments 0.5, 1, 3, and 5.5 kb in size. Give a possible restriction map for the original fragment. (5 points)
3. (A) Which polymer has more configurations? (a) a 100 residue polysaccharide, (b) a 100 residue polypeptide, or (c) a 400 base nucleic acid. Explain why. (B) Will it more easily to determine the structure of the polysaccharide, polypeptide, or nucleic acid? Explain why. (5 points)
4. Amino acid analysis of an octapeptide gave the following results:
2 Ala, 1 Arg, 1 Asp, 1 Met, 2 Tyr, 1 Val, 1NH₄⁺
The following facts were observed:
 - (a) Partial acid hydrolysis of the octapeptide yield a dipeptide of the structure


 - (b) Chymotrypsin treatment of the octapeptide yielded two tetrapeptides each containing an alanine residue.
 - (c) Trypsin treatment of one of the tetrapeptides yielded two dipeptides.
 - (d) Cyanogen bromide treatment of another sample of the same tetrapeptide yielded a tripeptide and free Tyr.
 - (e) N-terminal analysis of the other tetrapeptide gave Asn.

What are the possible amino acid sequences of this octapeptide? (5 points) (You have to show how you deduce the sequence step by step.)

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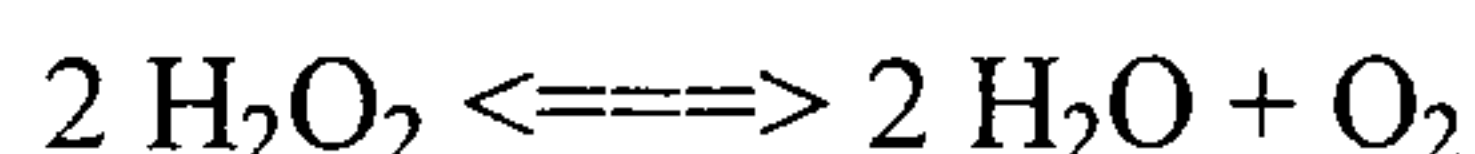
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5. The enzyme catalase catalyzes the decomposition of hydrogen peroxide:



The turnover number (k_{cat}) for catalase is $40,000,000 \text{ sec}^{-1}$. The K_m of catalase for its substrate H_2O_2 is 0.11M .

- (a). In an experiment using 3 nanomole/L of catalase, what is V_{max} ?
- (b). What is v when $[\text{H}_2\text{O}_2] = 0.75\text{M}$?
- (c). What is the catalytic efficiency of catalase?
- (d). In an experiment using 6 nanomole/L of catalase, what is V_{max} and what is K_m ? (5 points)
6. Draw structures of uracil, cytidine, cAMP, methionine, and fructose. (5 points)
7. Caffeine can inhibit the activity of 5'phosdiesterase. Predict the effect on glycogen phosphorylase activity when a person drinks a lot of caffeinated coffee. (5 points)
8. If no precautions are taken, blood that has been stored for some time becomes depleted in 2,3-BPG. What happens if such blood is used in a transfusion? (5 points)
9. What chemical functionality is provided to enzyme reactions by (a) pyridoxal phosphate, (b) coenzyme A, (c) vitamin B₁₂, (d) thiamine pyrophosphate, and (e) folic acid? (5 points)
10. The galactose-1-phosphate uridylyltransferase reaction proceeds via a ping-pong mechanism. Draw a diagram to show how a ping-pong mechanism would proceed for the uridylyltransferase. (5 points)
11. Describe the underlying rationale for the regulatory effect exerted on ribonucleotide reductase by ATP, dATP, dTTP, and dGTP (5 points)

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12. A typical intramitochondrial concentration of malate is 0.22 mM. If the ratio of NAD^+ to NADH in mitochondria is 20, and if the malate dehydrogenase reaction is at equilibrium, (a) calculate the concentration of oxaloacetate in the mitochondrion at 20°C. A typical mitochondrion can be thought of as a cylinder 1 μm in diameter and 2 μm in length. (b) Calculate the number of molecules of oxaloacetate in a mitochondrion. (c) In analogy with pH, what is pOAA? (10 points)
13. The standard reduction potential for (NAD^+/NADH) is -0.320V, and the standard reduction potential for (pyruvate/lactate) is -0.185V. (a) what is the standard free energy change (ΔG°) for the lactate dehydrogenase reaction? (b) what is the equilibrium constant (K_{eq}) for this reaction? (c) If [pyruvate] = 0.05mM and [lactate] = 2.9 mM and ΔG for the lactate dehydrogenase reaction = -15kJ/mol in erythrocytes, what is the [NAD^+/NADH] ratio under these conditions? (10 points)
14. What is the Shine-Dalgarno sequence? What does it do? The efficiency of protein synthesis initiation may vary by as much as 100-fold for different mRNAs. How might the Shine-Dalgarno sequence be responsible for this difference? (10 points)
15. Assume DNA replication proceeds at a rate of 100 base pairs per second in human cells and origins of replication occur every 300 kbp. Assume also that DNA polymerase III is highly processive and only 2 molecules of DNA polymerase III are needed per replication fork. How long would it take to replicate the entire diploid human genome (assume 6×10^9 bp of DNA)? How many molecules of DNA polymerase does each cell need to carry out this task? (10 points)