※ 注意：請於試卷上「非選擇題作答區」內依序作答，並應註明作答之大題及其題號。

1. Kornberg and his colleagues incubated soluble extracts of *E. coli* with a mixture of dATP, dTTP dGTP, and dCTP, all labeled with ^{32}P in the α-phosphate group. After a time, the incubation mixture was treated with trichloroacetic acid, which precipitates the DNA but not the nucleotide precursors. The precipitate was collected, and the extent of precursor incorporation into DNA was determined from the amount of radioactivity present in the precipitate. (6%)

a. If any one of the four nucleotide-precursors were omitted from the incubation mixture, would radioactivity be found in the precipitate? Explain.

b. Would ^{32}P be incorporated into the DNA if only dTTP were labeled? Explain.

c. Would radioactivity be found in the precipitate if ^{32}P labeled the β or γ phosphate rather than the α phosphate of the deoxyribonucleotides? Explain.

2. Order the duplex DNA molecules (only one strand of the sequences is presented) show below from lowest to highest melting temperature. Explain why. (3%)

5'-AAGTTCTCTGAA-3'
5'-AGTCGTCAATGCAG-3'
5'-GGACCTCTCAGG-3'

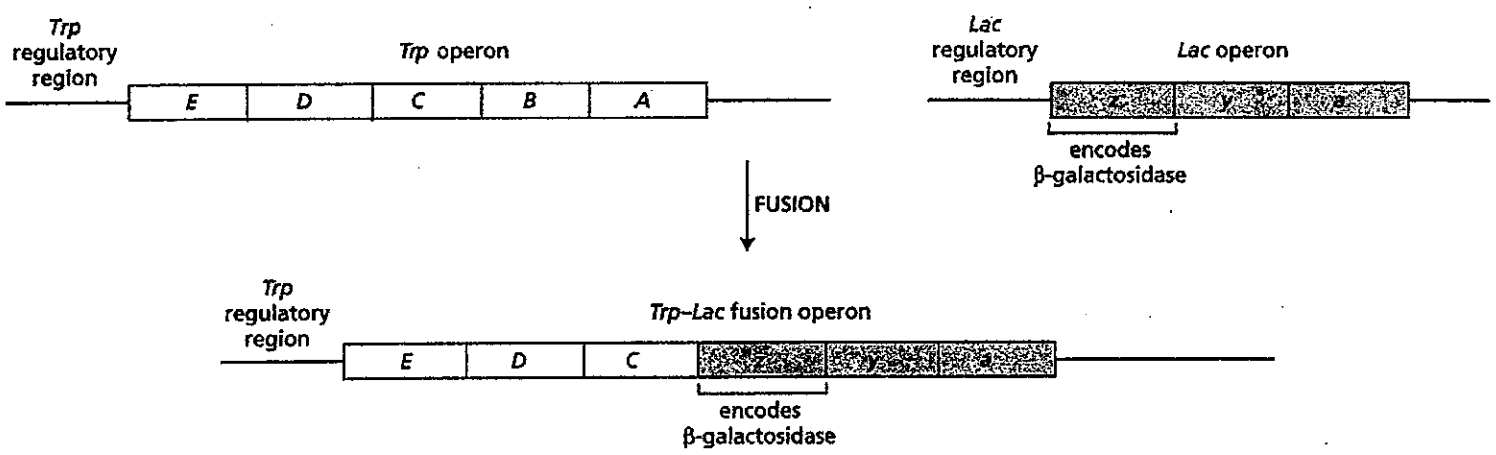
3. You are given two samples of DNA, each of which melts at 92°C when thermal denaturation is carried out. After denaturing the DNA, you mix the two samples together and then cool the mixture to allow the DNA strands to reassociate. When the newly reassociated DNA is denatured a second time, the sample now melts at 85 °C. (6%)

a. How might you explain the lowering of the melting temperature from 92 °C to 85 °C?

b. What kind of experiment could be carried out to test your hypothesis?

c. If the newly reassociated DNA had melted at 92 °C instead of 85 °C, what conclusions might you have drawn concerning the base sequences of the two initial DNA samples?

4. Imagine that you have created a fusion between the Trp operon, which encodes the enzymes for tryptophan biosynthesis, and the Lac operon, which encodes the enzymes necessary for lactose utilization (Figure below). Under which set of conditions (A-F below) will β-galactosidase be expressed in the strain that carries the fused operon? (3%)



a. Only when lactose and glucose are both absent.

b. Only when lactose and glucose are both present.

c. Only when lactose is absent and glucose is present.

d. Only when lactose is present and glucose is absent.

e. Only when tryptophan is absent.

f. Only when tryptophan is present.

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5. The plasma membrane of an animal cell consists of 45% by weight of phospholipid and 55% protein. What is the mole ratio (moles of lipid/moles of protein) if the average molecular weight of phospholipids is 750 and the average molecular weight of membrane proteins is 50,000? (2%)

6. What is high-density lipoproteins (HDL)? How HDL is formed? (6%)

7. What would happen to the absorption of dietary cholesterol and triacylglycerol if pancreatic lipase is inhibited? (5%)

8. Can our body synthesize docosahexaenoic acid (DHA)? If yes, how? (5%)

9. Briefly explain why starch and cellulose have different physical shapes and biological properties even though they have the same chemical composition. (3%)

10. True or false: the Krebs cycle is a part of anaerobic metabolism because oxygen is not involved in any reactions in the cycle. Please explain your reasoning. (3%)

11. Briefly discuss why each of three common forms of galactosemia involves impaired utilization of galactose. (3%)

12. What are the three basic steps in a single PCR cycle? Which step is typically performed at the highest temperature? (3%)

13. Gluconeogenesis is not simply a reversal of glycolysis. Why is this so? (4%)

14. Describe amino acid catabolism. (8%)

15. There are different platforms of DNA deep sequencing: pyrosequencing, sequencing by ligation, sequencing by synthesis, SMRT sequencing and semiconductor sequencing. Pick one and describe how it works. Compare it with Sanger sequencing. (8%)

16. Please explain the following four types of DNA mutations and their effects on protein products: “missense mutation”, “nonsense mutation”, “silent mutation”, “frameshift mutation”. (4%)

17. Please explain what is ubiquitin, how ubiquitin conjugates to different substrates, and its function in protein degradation control. (4%)

18. Please draw the structure of peptide bond and explain how hydrogen bond is formed in secondary structures such as α-helix and β-sheet. (4%)

19. What is ribozyme? Please explain whether ribosome is a ribozyme and the reason. (4%)

20. A. Why most enzymes are made of proteins? (4%) (Short answers are sufficient!)
    B. Enzymes are known to be stereospecific catalysts. What does the term “stereospecific” mean? How do enzymes achieve stereospecificity? (4%)

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21. When we characterize the kinetic properties of an enzyme, most often we start from a plot of "initial rate (V_o)" vs "substrate concentration [S]". (Short answers are sufficient!)

A. Please show how this "V_o–[S]" plot would look like for a non-allosteric enzyme. Please label the K_m and V_{max} in this plot. (4%)

B. Please show how this "V_o–[S]" plot would look like for an allosteric enzyme (assuming that the substrate itself is a positive, homotropic allosteric effector). Please show how the plot would change in the presence of a negative allosteric effector. (4%)

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