1. What structural features allow biological polymers to be informational macromolecules? Is it possible for polysaccharides to be informational macromolecules? You are encouraged to give example(s) to justify your answer. (10%)

2. Assume that mitochondria are cylinders 1.5 μm in length and 0.6 μm in diameter. (10%)
   (a) What is the volume of a single mitochondrion?
   (b) Oxaloacetate is an intermediate in the citric acid cycle, an important metabolic pathway localized in the mitochondria of eukaryotic cells. The concentration of oxaloacetate in mitochondria is about 0.03 μM. How many molecules of oxaloacetate are in a single mitochondrion?

3. Please answer the following questions based on your knowledge in the structural characteristics and properties of protein. (10%)
   (1) Explain why, for proteins with a single transmembrane segment, the segment is a hydrophobic helix. Why a helix? Why hydrophobic residue?
   (2) Please list three distinctive features of enzymes that distinguish them from chemical catalysts and briefly explain.

4. Considering the enzymatic reaction listed below, please match the descriptions in the first column with the terms in the second column based on your knowledge on enzyme kinetics. (10%)

$$S \leftrightarrow P$$

Here, v is the velocity or rate of the reaction

a. $d[P]/dt = d[S]/dt$	1. K_m
b. v at $[S] = \infty$	2. V_{max}
c. $[S]$ when $v = V_{max}/2$	3. V_{max}/E_T
d. k_{cat}	4. $1/V_{max}$
e. $1/v$ when $1/[S] = 0$	5. Equilibrium

(背面仍有題目,請繼續作答)

5. Please answer the following questions based on your understanding in Krebs cycle in carbohydrates metabolism. (10%)
   a. Complete the following reaction and name the enzyme complex that catalyzes it.

      Pyruvate + CoA + ____ → acetyl-CoA + ___ + ___ + CO_2

   b. This enzyme complex (in your answer above) uses five coenzymes. Name the coenzymes.
   c. The Krebs cycle is also known as TCA (tricarboxylic acid) cycle. Identify the tricarboxylic acids in the cycle.

6. Match the columns based on your knowledge on DNA replication.
   In the blank " j " you can write down any one of the molecules that is not included in this question but you know it is also involved in DNA replication and the match "10" correspondingly. (10%)

a. DNA gyrase	1. Rep protein
b. Helicase	2. Joins 3' hydroxyl to 5' phosphate
c. Leading strand	3. ATP-dependent dsDNA unwinder
d. Lagging strand	4. RNA polymerase
e. Primase	5. Okazaki fragments
f. beta-subunit of DNA polIII	6. Attaches holoenzyme to template
g. DNA ligase	7. 3' end toward replication fork
h. SSB	8. Type II topoisomerase
i. Localizes Helicase to replication fork	9. Blocks DNA secondary structure formation
j. _____	10. _____

7. Based on your knowledge on enzymes, proteins and molecular biology, can you correctly restate the "one-gene, one-enzyme hypothesis"? Please provide the rationale for your answer in detail. (10%)

8. X-gal and IPTG are compounds often used in DNA cloning and protein induction.
   (1) Please describe in detail the principle of blue-white screening. (5%)
   (2) How does induction by IPTG differ from induction by lactose via allolactose? (5%)

9. What are the differences between gene knockout and gene knockdown? Please include in your answer a brief description on the molecular mechanisms of these two methods in mammalian systems and the comparison between them. (10%)

10. What are the chemical characteristics and biological importance of buffer system in the internal environment of a living organism? Please also briefly describe the significance of the two most important buffer systems in our bodies. (10%)