※ 考生請注意：本試題不可使用計算機 請勿在本試題紙上作答，否則不予計分

# Part I：50%

## I. Choose the answer (or answers) of the following question (2% each)

1. Which of the following are not general characteristics of enzymes?
   (A) All enzymes are proteins.
   (B) Enzymes increase reaction rates by lowering the activation energy barrier.
   (C) Enzyme-Substrate complex are held together by noncovalent interactions (H bonds, hydrophobic interactions, ionic bonds).
   (D) Enzymes usually are substrate specific.
   (E) All enzymes show allosteric properties.

2. Avidin, a 70-kDa protein in egg white, has very high affinity for biotin. In fact, it is a highly specific inhibitor of biotin enzymes. Which of the following conversions would be blocked by the addition of avidin to a cell homogenate?
   (A) Pyruvate→ phosphoenolpyruvate;
   (B) Glucose → pyruvate;
   (C) Pyruvate → oxaloacetate;
   (D) Malate → oxaloacetate;
   (E) Oxaloacetate → glucose;

3. Which of the following statements about the citric acid cycle are true?
   (A) It generates three NADH, one NADPH, and one GTP for each acetyl CoA.
   (B) It is the only metabolic process in aerobic organisms that produces ATP.
   (C) Its intermediates may be removed to make the amino acids glutamate and aspartate.
   (D) It is linked to the electron transport chain through succinate dehydrogenase.
   (E) None of above.

4. What is the cellular location of the enzymes of the citric acid cycle?
   (A) Cytoplasmic membrane
   (B) Cytoplasm
   (C) Nucleus
   (D) Mitochondria
   (E) Riosomes

(背面仍有題目,請繼續作答)

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5. Which of the following compounds or metabolic processes are related to cholesterol synthesis or degradation?
   (A) Squalene
   (B) β oxidation
   (C) Acetyl CoA
   (D) Mevalonate
   (E) Palmitate

## II. Brief answer the following question (5% each)

1. Sucrose is commonly used to preserve fruits. Why is glucose **not** suitable for preserving foods?

2. In enzyme kinetics $K_M$ is an important constant for substrate binding, whereas in transport $K_{transport}$ is used to define the process. How are $K_M$ and $K_{transport}$ similar and how are they different?

3. Patients in shock will often suffer from lactic acidosis due to a deficiency of $O_2$. Why does a lack of $O_2$ lead to lactic acid accumulation? One treatment of shock is to administer dichloroacetate, which inhibits the kinase associated with the pyruvate dehydrogenase complex. What is the biochemical rationale for this treatment?

4. Write a balance equation for the conversion of glycerol into pyruvate. Which enzymes are required in addition to those of the glycolytic pathways?

5. Tabun and sarin have been used as chemical-warfare agents, and parathion has been employed as insecticide. What is the molecular basis of their lethal actions?

6. The fraction of open channels at 5mV increments beginning at -45 mV and ending at +5 mV at 20°C is 0.02, 0.04, 0.09, 0.19, 0.37, 0.59, 0.78, 0.89, 0.95, 0.98, and 0.99.
   At what voltage are half the channels open?

7. During DNA replication in a mammalian cell, why would replication come to a halt (or stop replication) in the absence of topoisomerase II?

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8. Suppose that the single-stranded RNA from tobacco mosaic virus was treated with a chemical mutagen, those mutants were obtained having serine or leucine instead of proline at a specific position, and that further treatment of these mutants with the same mutagen yield phenylalanine at this position.

(Pro→ Ser or Leu→Phe)

According to the following standard genetic code:

(A) what are the plausible codon assignments for these four amino acids?

(B) was the mutagen 5-bromouracil, nitrous acid, or an acridine dye?

**The Genetic Code (RNA to Amino Acids)***

| First Position (5′ end) | Second Position | | | | Third Position (3′ end) |
|---|---|---|---|---|---|
| | U | C | A | G | |
| U | Phe | Ser | Tyr | Cys | U |
| | Phe | Ser | Tyr | Cys | C |
| | Leu | Ser | Stop (och) | Stop | A |
| | Leu | Ser | Stop (amb) | Trp | G |
| C | Leu | Pro | His | Arg | U |
| | Leu | Pro | His | Arg | C |
| | Leu | Pro | Gln | Arg | A |
| | Leu | Pro | Gln | Arg | G |
| A | Ile | Thr | Asn | Ser | U |
| | Ile | Thr | Asn | Ser | C |
| | Ile | Thr | Lys | Arg | A |
| | Met (start) | Thr | Lys | Arg | G |
| G | Val | Ala | Asp | Gly | U |
| | Val | Ala | Asp | Gly | C |
| | Val | Ala | Glu | Gly | A |
| | Val (Met) | Ala | Glu | Gly | G |

*"Stop (och)" stands for the ochre termination triplet, and "Stop (amb)" for the amber, named after the bacterial strains in which they were identified. AUG is the most common initiator codon; GUG usually codes for valine, and CUG for arginine, but, rarely, these codons can also code for methionine to initiate an mRNA chain.

## Part II：Short answer questions：50%

1. Please describe the following process (together with diagrams):
   A. Glycolysis (5%)
   B. Gluconeogenesis (5 %)

2. There are three different forms of DNA double helix: A-form, B-form and Z-form. Please give brief descriptions on each form and clearly state the differences between them. (10%)

(背面仍有題目,請繼續作答)

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3. Please define the following terms (together with diagrams) in respect to the protein structure：
   A. Primary structure (2.5 %)
   B. Secondary structure (2.5 %)
   C. Tertiary structure (2.5 %)
   D. Quaternary structure (2.5 %)

4. Nuclear magnetic resonance spectroscopy (NMR) and X-ray crystallography are techniques commonly used for protein structure determination. Please describe both techniques in terms of mechanisms, applications and limitations. (10%)

5. *In vitro* kinase assay is a laboratory procedure that measures the rate of enzyme reactions. It can be used to determine the target specificity and potency of a drug (kinase inhibitor) *in vitro*. Consider the following situation: "Drug X" shows target specificity towards both Aurora-A and Aurora-B kinase *in vitro* as revealed by the *in vitro* kinase assay, and results are shown in the below listed table. However, "Drug X" induces cancer cell death mainly through inhibition of AKT kinase instead of Aurora-A and Aurora-B kinase. Please give possible explanations to this phenomenon. (*i.e. In vitro* = in a test tube; $IC_{50}$ = half maximal inhibitory concentration) (10 %)

| **Kinase** | ***In vitro* kinase $IC_{50}$ (nM)** |
|---|---|
| ***Aurora-A*** | **80** |
| ***Aurora-B*** | **90** |
| *AKT* | 300 |
| *cMET* | 2500 |
| *FLT3* | >10000 |
| *mTOR* | >10000 |