I. 單選題 (共 70 分)

1. (2%) What is the ionic strength of a 0.04 M solution of $Fe_2(SO_4)_3$?
    (A) 0.54 (B) 0.73 (C) 0.82 (D) 0.6 (E) 0.97

2. (2%) What is the $[H^+]$ of a solution with pH of 11.11?
    (A) 8.35×10^{-13} M (B) 7.76×10^{-12} M (C) 6.16×10^{-13} M (D) 4.38×10^{-13} M (E) 1.75×10^{-12} M

3. (2%) The tertiary structure of a protein is usually a result of which of the following interactions?
    (A) Hydrophobic interactions (B) Electrostatic interactions (C) Hydrogen bonding (D)Van der Waal interactions (E) All of above

4. (2%) _____, an early intermediate of fatty acid synthesis, inhibits carnitine acyltransferase I, preventing fatty acid entry into mitochondria.
    (A) Acetyl-CoA (B) hydroxyacyl-CoA (C) Malonyl-CoA (D) Enoyl-CoA (E) Phytanoyl-CoA

5. (2%) Which of following about the function of enzyme used in recombination DNA technology is correct?
    (A) DNA ligase fills gaps in duplexes by stepwise addition of nucleotides to 3' ends
    (B) Polynucleotide kinase makes a DNA copy of an RNA molecule
    (C) Type II restriction endonucleases cleave DNAs at specific base sequences
    (D) Exonuclease III adds homopolymer tails to the 3'-OH ends of a linear duplex
    (E) Terminal transferase removes nucleotide residues from the 3' ends of a DNA strand

6. (2%) The activity of chymotrypsin will be tremendously affected by change of ?
    (A) Ser^{195} and Leu^{16}
    (B) His^{57} and C-terminal
    (C) Asp^{102}, His^{57}, & Ser^{195}
    (D) Ile^{16} and Glu^{194}
    (E) Ile^{16}, Arg^{194}, & Gly^{193}

7. (2%) Please order the following procedures for the enzyme-linked immunosorbent assay (ELISA).
    I.   Incubate with primary antibody against specific antigen
    II. Coat surface with sample (antigen)
    III. Block unoccupied sites with nonspecific protein
    IV. Formation of colored product indicates presence of specific antigen
    V.   Incubate with secondary antibody-enzyme complex that binds primary antibody
    VI. Add substrate
    (A) III → II → IV → I → VI → V
    (B) II → III → I → V → VI → IV
    (C) II → III → I → IV → V → VI
    (D) VI → IV → II → I → III → V
    (E) I → II → IV → III → V → VI

注意：背面有試題

8. (2%) Which of following description is NOT correct regarding the genetic code (from RNA to amino acid)?
   (A) Synthesis of all polypeptide chains in prokaryotic and eukaryotic cells begins with the amino acid methionine
   (B) In most mRNAs, the start *(initiator)* codon specifying the amino-terminal methionine is AUG
   (C) The three codons UAA, UGA and UAG do not specify amino acids but constitute stop *(termination)* codons that mark the carboxyl terminus of polypepetide chains in almost all cells
   (D) In a few bacterial mRNAs, GUG and GUC occasionally can be used as an initiator codon for methionine in eukaryotes
   (E) Most amino acids are encoded by more than one codon, only methionine and tryptophan have a single codon

9. (2%) What is the pH of a solution that contains 0.2 M sodium acetate and 0.6 M acetic acid (pK_a = 4.76)?
   (A) 3.2 (B) 4.3 (C) 6.8 (D) 7.4 (E) 9.5

10. (2%) The protein calcineurin binds to the protein calmodulin with an association rate of 8.9×10^3 $M^{-1}s^{-1}$ and an overall dissociation constant, K_d of 10 nM. Please calculate the dissociation rate k_d?
    (A) 8.9×10^{-5} (B) 5.6×10^{-5} (C) 7.42×10^{-6} (D) 1.83×10^{-4} (E) 3.73×10^{-5}

11. (2%) Which of the following cell process is NOT energized by Adenosine triphosphate (ATP) molecules?
    (A) Translocation of RNA polymerase
    (B) Translocation of DNA polymerase
    (C) Movement of Ribosome along mRNA molecules during translation
    (D) Rotation of viral capsid motor leading to DNA packaging
    (E) Transport of chromosomes during mitosis

12. (2%) The amino acid with smallest molecular weight or simplest structure is
    (A) Glycine (B) Alanine (C) Cysteine (D) Serine (E) Proline

13. (2%) Which of the following description regarding the cell membrane transporter is correct?
    (A) Ca^{2+} transporters of the sarcoplasmic and endoplasmic reticulum are examples of F-type ATPases
    (B) V-type ATPase proton pumps are central to energy-conserving mechanisms in mitochondria
    (C) P-type ATPases are cationic transporters that can be reversibly phosphorylated by ATP
    (D) Na^+K^+ATPases use ATP as the energy source to conduct a variety of active transport processes
    (E) None of the above

14. (2%) At the anticodon *wobble* position, a given base "I (*Inosine*)", a deaminated product of adenine, in tRNA can base-pair with _____ in mRNA?
    (A) U (B) A & G (C) C & A (D) C & U (E) C, A, & U

15. (2%) What is the first reaction in citric acid cycle in which there are total 8 reaction steps?
    (A) Oxidation of α-ketoglutarate to succinyl-CoA and CO_2
    (B) Oxidation of malate to oxaloacetate
    (C) Formation of isocitrate via cis-aconitate
    (D) Condensation of acetyl-CoA with oxaloacetate to form citrate
    (E) Oxidation of succinate to fumarate

注意：背面有試題

16. (2%) _____ and _____ are electron carriers in mitochondria and chloroplasts, respectively.
   (A) Ubiquinones / Plastoquinones
   (B) Prostaglandins / Thromboxanes
   (C) Galactolipids / Sphingolipids
   (D) Triacylglycerols / Leukotrienes
   (E) Steroid hormones / Diacylglycerol

17. (2%) Which of the following regarding the pair of enzyme and its cofactor is NOT correct?
   (A) Pyruvate kinase / K^+
   (B) Ribonucleotide reductase / Mn^{2+}
   (C) Urease / Ni^{2+}
   (D) Hexokinase / Mg^{2+}
   (E) Cytochrome oxidase / Zn^{2+}

For question # 18 & 19:

Given an enzyme-catalyzed reaction A + B → P + Q at [A] = 2×10^{-5} M and [B] = 6.7×10^{-5} M. Assume that both A and B are added randomly to the enzyme where $K_A = 2.2 \times 10^{-4}$ M, $K_B = 1.9 \times 10^{-5}$ M, and V_{max} = 72.7 nmol/L/min, please calculate:

18. (2%) The velocity of the enzyme-catalyzed reaction at $\alpha = 1$ (the binding of one substrate has no effect on the binding of the other)?
   (A) 6.28 (B) 4.72 (C) 13.2 (D) 7.83 (E) 9.52 nmol/L/min

19. (2%) The velocity of the enzyme-catalyzed reaction at $\alpha = 0.1$ (the binding of one substrate decreases the dissociation constant for the other by a factor of 10)?
   (A) 42.6 (B) 66.8 (C) 35.6 (D) 24.4 (E) 29.79 nmol/L/min

20. (2%) Which of the following represent stop codons that can mark the carboxyl terminus of polypeptide chains?
   I.   UCG
   II. UGA
   III. UGG
   IV. UAA
   V.   UAG
   VI. UUA
   (A) I, III, V (B) III, IV, VI (C) II, IV, V (D) II, IV, VI (E) I, IV, V

21. (2%) The specific chemical site on an antigen that can bind with immunoglobulin or T cell receptor is called
   (A) Epitope (B) Antibody (C) MHC site (D) FAB region (E) FC region

22. (2%) Pepsin can cleave polypeptides at specific points except:
   (A) Leucine (B) Phenylalanine (C) Tyrosine (D) Tryptophan (E) Lysine

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■ For question # 23 - 27:
    I.   Lysine
    II.   Tyrosine
    III. Histidine
    IV. Threonine
    V.   Asparagine
    VI. Proline

23. (2%) Which of the following amino acids are all positively charged?
(A) I, II, III (B) I, VI (C) I, V, VI (D) I, III (E) II, IV, V

24. (2%) Which of the following amino acids are all hydrophobic?
(A) I, II (B) II, VI (C) III, VI (D) I, IV (E) None of above

25. (2%) How many amino acid(s) is/are polar with uncharged R group?
(A) 0 (B) 1 (C) 2 (D) 3 (E) 4

26. (2%) Which of the following amino acid(s) contain aromatic residues?
(A) II, III (B) I, IV, V (C) II, III, VI (D) IV, V (E) II, VI

27. (2%) How many amino acid(s) contain(s) sulfur atom?
(A) 0 (B) 1 (C) 2 (D) 3 (E) 4

28. (2%) Each strand of DNA is stabilized by?
(A) Electrostatic interactions
(B) Hydrogen bonds
(C) Ionic bonds
(D) Hydrophobic interactions
(E) Phosphodiester bonds

29. (2%) Which of the following description about DNA denaturation is correct?
(A) Molecules that contain a greater proportion of Adenine and Thymine require higher temperature to denature
(B) Molecules in the environment with low ion concentration require lower temperature to denature
(C) Molecules in the environment with formamide require higher temperature to denature
(D) Molecules in the environment with pH = 7.0 required lower temperature to denature
(E) None of the above

30. (2%) Human pancreatic ribonuclease has 128 amino acid residues. What is the minimum number of nucleotide pairs required to code for this protein?
(A) 64 (B) 128 (C) 256 (D) 384 (E) 512

31. (2%) Which of the following is an amino acid not found in proteins?
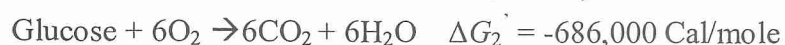(A) Glutamic acid (B) Phenylalanine (C) Carnitine (D) Serine (E) Isoleucine

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32. (2%) Which of the following description regarding immune system is NOT correct?
(A) Human have five classes of immunoglobulins, each with different biological functions
(B) The function of macrophages is to ingest large particles and cells by phagocytosis
(C) Cytotoxic T cells induce the proliferation of B cells and helper T cells that produce immunoglobulins
(D) Cytotoxic T cells may interact with infected host cells through receptors on T-cell surface
(E) B cells can produce and secrete antibodies

33. (2%) Which of the following compound is involved with the cholesterol formation?
(A) Acetyl-CoA
(B) β-hydroxy-βmethylglutaryl-CoA
(C) Dimethylallyl pyrophosphate
(D) Isopentenyl pyrophosphate
(E) All of the above

For question# 34 & 35

34. (2%) Please calculate the ΔG' for the complete oxidation of lactic acid to carbon dioxide and water.
Lactic acid + $3O_2$ → $3CO_2$+$3H_2O$
Hint: Given the reactions below:
Glucose → 2 lactic acid　　　　　$\Delta G_1' = -52,000$ Cal/mole
Glucose + $6O_2$ → $6CO_2$ + $6H_2O$　　$\Delta G_2' = -686,000$ Cal/mole
(A) -525,000 (B) -158,000 (C) -713,000 (D) -408,000 (E) -317,000 Cal/mole of lactic acid

35. (2%) How many moles of ATP could be synthesize in the process at 40% efficiency? Assume each mole of ATP requires 7700 Cal.
(A) 15 (B) 16 (C) 17 (D) 18 (E) 19 moles of ATP

參考用

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II. 計算題 (共 30 分)

1. An enzyme was assayed at an initial substrate concentration of 2×10^{-5} M, and half of the substrate was used in 6 min. The K_m for the substrate is 5×10^{-3} M.

   (a) Please demonstrate the relation: $\log \dfrac{[S]_0}{[S]} = \dfrac{kt}{2.3}$ (10%)

   Hint: At very low substrate concentrations, (e.g., $[S] < 0.01 \, K_m$), the reaction is *first-order*:

   $$-\frac{d[S]}{dt} = V = \frac{V_{\max}}{K_m}[S] = k[S]$$

   (b) Please calculate the V_{max}. (5%)

   (c) Please calculate the concentration of product produced by 15 min. Assume the reaction volume is constant. (5%)

2. A solution containing NAD^+ and NADH had an optical density in a 1 cm cuvette of 0.483 at 340 nm and 1.365 at 260 nm. Please calculate the concentrations of the oxidized and reduced forms of the enzyme in the solution. Both NAD^+ and NADH absorb at 260 nm, but only NADH absorbs at 340 nm. The extinction coefficients (ε) are given below. (10%)

Compound	ε (M^{-1} cm^{-1})	
	260 nm	340 nm
NAD^+	18000	0
NADH	15000	6220

注
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參考用