

國立成功大學

113學年度碩士班招生考試試題

編 號：60

系 所：生物科技與產業科學系

科 目：生物化學

日 期：0202

節 次：第 1 節

備 註：不可使用計算機

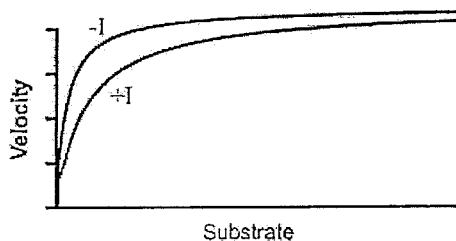
※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

一、選擇題(請選擇一個最好的答案，每題 2 分，共 40 分)(Multiple choice questions, 40% in total)

1. Metal ions play an important role in the enzymatic catalytic reaction. Which statement describing the functions of the metal ions in metal-activated enzymes is **NOT** true?

- Metal ions functions as nucleophiles attacking the substrates.
- Metal ions assist to develop the negative charge during reactions.
- Metal ions could stabilize the increased electron density in the active site.
- Metal ions play a role as electrophilic catalysts.
- Hexokinase contains magnesium ion.

2. The graphical pattern obtained from kinetic experiments shows the effects after adding an inhibitor, I.



This inhibitor is a _____.

- competitive inhibitor
- noncompetitive inhibitor
- mixed noncompetitive inhibitor
- uncompetitive inhibitor
- None of the above

3. Following which is **not** a standard amino acid?

- Glycine
- Ornithine
- Tyrosine
- N-formylmethionine
- Tryptophan

4. Which of the following methods is effective for separating proteins on the basis of their net charge?

- Size exclusion chromatography
- Ammonium sulfate precipitation
- SDS-PAGE
- Hydrophobic interaction chromatography
- Ion exchange

5. Following which is the protein quantitation method based on reduction of Cu^{2+} to Cu^{+} ?

- a. Bradford method
- b. Biuret method
- c. Western blotting
- d. Absorbance at 280 nm
- e. Mass spectrometry

6. Following which statements are correct regarding stability of nucleotides **except**

- a. RNA is readily hydrolyzed by dilute acid
- b. DNA is depurinated by dilute acid
- c. DNA is not susceptible to base
- d. RNA is alkali labile
- e. All of the above

7. The chemical structure of γ -linolenic acid (GLA) is shown as below:



Following which statements are correct regarding GLA **except**

- a. GLA is a polyunsaturated fatty acid
- b. GLA is a cis fatty acid
- c. GLA is an omega-3 fatty acid
- d. GLA is a n-6 fatty acid
- e. GLA is a C18 fatty acid

8. Following which statement is **false** regarding cholesterol biosynthesis?

- a. Primary occurs in liver.
- b. Cholesterol synthesis occurs in the cytosol.
- c. The rate-limiting step is catalyzed by HMG-CoA synthase.
- d. Squalene is one of the precursors for cholesterol.
- e. Cholesterol is synthesized from squalene via lanosterol.

9. Following descriptions about mitochondrial beta-oxidation, which one is **not** true?

- a. Produce FADH_2 and NADH
- b. An important water source for animals
- c. The complete breakdown of palmitic acid ($\text{C}_{16:0}$) requires 8 cycles of mitochondrial beta-oxidation
- d. Complete β -oxidation of one palmitic acid yields 106 molecules of ATP
- e. A palmitic acid yields eight acetyl-CoAs

10. Following which statements are corrects regarding ketogenesis in mammals except
- Take place in liver
 - Origin from excess acetyl-CoA in liver mitochondrial matrix
 - HMG-CoA reductase participates in ketogenesis
 - The ketone body β -hydroxybutyrate (BHB) is an essential carrier of energy from the liver to peripheral tissues when the supply of glucose is too low for the body's energetic needs
 - Accumulation of ketone bodies may result in ketoacidosis
11. Which of the following pairs would be the best buffer at pH 10.0?
- Acetic acid and sodium acetate ($pK_a = 4.76$)
 - H_2CO_3 and $NaHCO_3$ (pK_a values are 3.77 and 10.4)
 - Lactic acid and sodium lactate ($pK_a = 3.86$)
 - NaH_2PO_4 and Na_2HPO_4 (pK_a values are 2.1, 7.2, 12.4)
 - Sodium succinate and succinic acid ($pK_a = 4.21$)
12. As a result of mutarotation, D-glucose exists in all of the following forms except:
- L-glucopyranose.
 - β -anomer.
 - free aldehyde.
 - α -anomer.
 - all are true.
13. Cartilage-matrix proteoglycan has all of the following properties except:
- responsible for the flexibility and resiliency of cartilage.
 - has a hyaluronic acid binding domain.
 - has reversible hydration-dehydration properties.
 - contains both N-linked and O-linked oligosaccharides.
 - is an integral transmembrane protein.
14. Under anaerobic conditions, skeletal muscle generates lactate from pyruvate to:
- lower the pH.
 - promote release of oxygen from hemoglobin.
 - generate additional ATP.
 - be warning of muscle fatigue.
 - regenerate NAD^+ for further glycolysis.
15. Seven of the ten reactions of glycolysis are reversible (ΔG near zero) and can be used in reverse of glycolysis for gluconeogenesis. The three irreversible reactions are catalyzed by:

- a. hexokinase, phosphoglycerate kinase, pyruvate kinase.
- b. triose phosphate isomerase, phosphoglycerate mutase, pyruvate kinase.
- c. enolase, phosphoglycerate kinase, phosphofructokinase-1.
- d. hexokinase, phosphoglucoisomerase, glyceraldehyde-3-phosphate dehydrogenase.
- e. hexokinase, phosphofructokinase-1, pyruvate kinase.

16. Which enzymes of the TCA cycle catalyze oxidative decarboxylation reactions?

- a. malate dehydrogenase and citrate synthase
- b. fumarase and succinate dehydrogenase
- c. α -ketoglutarate dehydrogenase and succinate dehydrogenase
- d. isocitrate dehydrogenase and α -ketoglutarate dehydrogenase
- e. aconitase and succinate dehydrogenase

17. An individual with von Gierke's disease lacks the enzyme _____ which is a liver enzyme used to maintain _____. As a result, the patient is _____.

- a. glycogen synthase; liver glycogen; fat
- b. glycogen synthase; ATP levels; weak
- c. phosphoprotein phosphatase-1; blood glucose; hypoglycemic
- d. glucose-6-phosphatase; blood glucose; hypoglycemic
- e. glucose-6-phosphatase; muscle glycogen; weak

18. If both NADPH and ribose-5-P are needed which of the following best represents the net reaction of the pentose phosphate pathway?

- a. $4 \text{ Fructose-6-P} + 2 \text{ glyceraldehyde-3-P} \rightarrow 6 \text{ ribose-5-P}$
- b. $3 \text{ Glucose-6-P} + 6 \text{ NADP}^+ \rightarrow 6 \text{ NADPH} + 3 \text{ CO}_2 + 2 \text{ Fructose-6-P} + 1 \text{ glyceraldehyde-3-P} + 6 \text{ H}^+$
- c. $\text{Glucose-6-P} + 2 \text{ NADP}^+ + 2 \text{ H}_2\text{O} \rightarrow 2 \text{ NADPH} + \text{CO}_2 + \text{ribose-5-P} + 2 \text{ H}^+$
- d. $\text{Glucose-6-P} + 12 \text{ NADP}^+ + 6 \text{ H}_2\text{O} \rightarrow 12 \text{ NADPH} + 6 \text{ CO}_2 + 12 \text{ H}^+ + \text{Pi}$
- e. None of the above

19. In the process of amino acid biosynthesis, how are glutamic acid, glutamine, proline, and arginine all related?

- a. They are all derived from α -KG.
- b. They are all derivatives of acetyl CoA.
- c. They are all derivatives of pyruvate.
- d. They are all derived from aspartate.
- e. They are all derivatives of 3-phosphoglycerate.

20. All of the following are true of the urea cycle except:

- It helps in the excretion of excess nitrogen.
- It is mainly confined to the liver.
- It is linked to the citric acid cycle through fumarate.
- Stimulation of carbamoyl-phosphate synthetase I (CPS-I) decreases the activity of the urea cycle.
- It is completed by the regeneration of ornithine from arginine.

二、簡答題(每題配分顯示於題後，共 60 分) (Essays, 60% in total)

1. The relationship between substrate concentration ($[S]$) and reaction rate of enzyme A (V) are as follows:

$[S]$ (mM)	V ($\mu\text{M}/\text{min}$)
0.40	0.08
0.50	0.10
0.67	0.13
1.00	0.16
2.00	0.26

Try to calculate the V_{\max} and K_m of enzyme A using these values (6%). (Hint : plotting $1/v$ versus $1/[S]$ to get a double reciprocal plot, then use intercept of the line to get V_{\max} and K_m)

2. Given the molecular components glycerol, fatty acid, phosphate, long-chain alcohol, and carbohydrates:

- Which two are present in both waxes and sphingomyelin? (2%)
- Which two are present in both fats and phosphatidylcholine? (2%)
- Which are present in a ganglioside but not in a triacylglycerol? (2%)

3. The isoelectric point (pI) of $\sigma 32$ protein is 6.0.

- What is pI? (3%)
- The reason why $\sigma 32$ has lowest solubility when the surrounding pH equals to its pI. (3%)

4. A peptide hormone has the following sequencing:

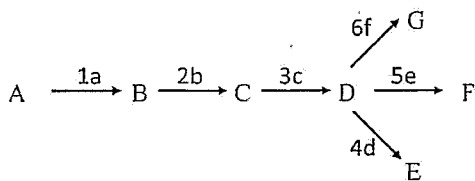
Tyr Ser Met Glu Asn Arg Trp Gly Lys

- Write the sequence using the one-letter abbreviations (縮寫). (3%)
- Approximate what charge of this peptide would you expect at pH 7? (3%)

5. HMG-CoA reductase is a key enzyme in cholesterol biosynthesis in animals (responsible for the conversion of HMG-CoA to mevalonate). The activity of HMG-CoA reductase is feedback inhibited by cholesterol, the end-product of cholesterol biosynthesis.

What would you expect to happen to the level of mevalonate in human plasma if one was to go from an ordinary to a vegetarian diet (素食)? Why? (6%)

6. A metabolic pathway present in an organism (such as medicinal plants, microbes, or animal cells) is shown in the figure below. The A to G indicate the metabolites and 1a to 6f indicate the enzymes that catalyze the step-wise reaction in the pathway. If a scientist would like to do metabolic engineering to enhance the production of valuable "E" metabolite in an organism, what are the possible ways to do it? Please explain it. (Note, the genes corresponding to the enzymes of 1a to 6f have been cloned and are available for use) (5%)



7. The United Nations climate conference, COP28, was held in Dubai of the United Arab Emirates (UAE) in December of 2023 to discuss a solution to reduce CO₂ emissions. The enzyme "ribulose-1, 5-bisphosphate carboxylase/oxygenase (RUBISCO)" is one of the enzymes involved in the Calvin cycle of photosynthesis in higher plants? Please explain the characteristics of the RUBISCO. In addition, please propose possible ways to relieve climate change by working on RUBISCO. (5%)
8. Glyphosate, a common herbicide sold commercially as Roundup, is a phosphoenolpyruvate (PEP) analog that acts as an uncompetitive inhibitor of 3-enolpyruvylshikimate-5-P synthase (EPSP synthase) involved in aromatic amino acid biosynthesis in plants. Please explain why "Glyphosate" is safe and widely used in the world. In addition, please describe how to generate a transgenic soybean (Roundup-ready crop) that is resistant to glyphosate (Roundup). (5%)
9. Patients with diabetes must measure their serum "glucose" concentration frequently, often several times a day. The advent of computerized, automated devices (blood glucose meters) for glucose monitoring has made this necessary chore easier, more accurate, and more convenient than it once was. You apply a drop of blood to a test strip and insert it into a small, electronic glucose meter, which measures the glucose in your blood. Please explain one of the possible biochemical (or chemical) principles for those devices commonly used for glucose measurement. (5%)
10. If an ATP synthase contains 12 c-subunits, 3 α -subunits and 3 β -subunits, how many protons must pass through this complex for every ATP molecule synthesized in mitochondria? Please explain it. (Assuming that all of the protons are used for ATP synthesis) (5%)

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11. Please explain how thioredoxin plays an important role in the regulation of ribonucleotide reductase for the synthesis of deoxynucleotides in animals or in the regulation of enzymes (e.g., fructose-1,6-bisphosphatase and ribulose-5-phosphate kinase) involved in the Calvin cycles of photosynthesis in plants. (5%)