

※ 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

一、選擇題（單選 5 題，每題 1 分；共 5 分）

1. Which of the following is considered as macromolecule?
  - A. Amino acid
  - B. Fatty acid
  - C. Nucleic acid
  - D. Lipoic acid
  - E. Chlorophyll
  
2. Energy requiring metabolic pathways that yield complex molecules from simpler precursors are:
  - A. amphibolic.
  - B. endergonic
  - C. autotrophic.
  - D. catabolic.
  - E. exergonic.
  
3. Which of the following is *not* correct concerning cooperative binding of a ligand to a protein?
  - A. It is usually a form of allosteric interaction.
  - B. It is usually associated with proteins with multiple subunits.
  - C. It rarely occurs in enzymes.
  - D. It results in a nonlinear Hill Plot.
  - E. It results in a sigmoidal binding curve.
  
4. Which of the following is *not* correct concerning 2,3-bisphosphoglycerate (BPG)?
  - A. It binds at a distance from the heme groups of hemoglobin.
  - B. It binds with higher affinity to fetal hemoglobin than to adult hemoglobin.
  - C. It stabilizes the T state of hemoglobin for oxygen.
  - D. It is an allosteric modulator.
  - E. It is normally found associated with the hemoglobin extracted from red blood cells.

(背面仍有題目,請繼續作答)

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5. The myoglobin and the subunits of hemoglobin have:
- A. no obvious structural relationship but very similar Hill coefficient upon oxygen binding .
  - B. very similar Hill coefficient upon oxygen binding, but different primary and tertiary structures.
  - C. very similar primary structures and similar Hill coefficient upon oxygen binding, but different tertiary structures.
  - D. very similar primary and tertiary structures, but different Hill coefficient upon oxygen binding .
  - E. very similar tertiary structures, but different primary structures and different Hill coefficient upon oxygen binding .

二、選擇題（單選 13 題，每題 2 分；共 26 分）

6. Which of the following statements concerning the bifunctional protein phosphofructokinase-2/fructose 2,6-bisphosphatase (PFK-2/FBPase-2) is correct?
- A. In the absence of fructose 2,6-bisphosphate (F26BP) as an allosteric effector, the activity of PFK-1 is enhanced (inhibiting glycolysis).
  - B. In the absence of F26BP as an allosteric effector, the activity of fructose 1,6-bisphosphatase is reduced (stimulating gluconeogenesis).
  - C. Glucagon, signaling low blood sugar, stimulates cAMP synthesis, which activates protein kinase A to phosphorylate PFK-2/FBPase-2.
  - D. The phosphorylation of PFK-2/FBPase-2 enhances PFK-2 activity and inhibits FBPase-2 activity of the enzyme, resulting in lower levels of F26BP.
  - E. None of the above.
7. Which one of the following statements concerning glycolysis is correct?
- A. Aerobically, oxidative decarboxylation of pyruvate forms ethanol that enters the citric acid cycle.
  - B. In yeast growing aerobically, pyruvate is converted to lactate.
  - C. Reduction of pyruvate to lactate regenerates a cofactor essential for glycolysis.
  - D. Under anaerobic conditions, pyruvate does not form because glycolysis does not occur.
  - E. None of the above.

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8. Xylulose 5-phosphate
- A. is a key regulator of carbohydrate and fat metabolism.
  - B. is a product of glycolysis pathway.
  - C. inactivates phosphoprotein phosphatase 2A, which dephosphorylates the bifunctional phosphofructokinase-2/fructose 2,6-bisphosphatase.
  - D. decreases the synthesis of all the enzymes required for fatty acid synthesis.
  - E. none of the above.
9. Pyruvate can be converted to glucose via gluconeogenesis or oxidized to acetyl-CoA.
- A. In the conversion of pyruvate to glucose, the first enzyme pyruvate carboxylase is allosterically inhibited by acetyl-CoA.
  - B. In the conversion of pyruvate to glucose, the first enzyme pyruvate dehydrogenase is allosterically inhibited by acetyl-CoA.
  - C. Pyruvate is oxidized to acetyl-CoA by pyruvate dehydrogenase complex, which is allosterically inhibited by acetyl-CoA.
  - D. Pyruvate is oxidized to acetyl-CoA by pyruvate dehydrogenase complex, which is allosterically activated by acetyl-CoA.
  - E. None of the above.
10. Which one of the following statements concerning glycogen phosphorylase is correct?
- A. Glycogen phosphorylase catalyzes phosphorolysis of the ( $\alpha 1 \rightarrow 6$ ) bonds at the branch points of glycogen.
  - B. Glycogen phosphorylase of liver acts as a glucose sensor.
  - C. Glycogen phosphorylase catalyzes the degradation of glycogen by hydrolysis of glycosidic bonds.
  - D. Glycogen phosphorylase degrades glycogen to form glucose 6-phosphate directly.
  - E. None of the above.
11. Phosphoprotein phosphatase-1 (PP1)
- A. can dephosphorylate glycogen phosphorylase, glycogen synthase, and phosphorylase kinase.
  - B. is allosterically inactivated by glucose-6-phosphate.
  - C. is phosphorylated by glycogen synthase kinase-3 (GSK3).
  - D. is inactivated by insulin-stimulated phosphorylation on  $G_M$  site 1.
  - E. none of the above.

(背面仍有題目,請繼續作答)

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12. Which one of the following molecules is a component of extracellular matrix of animal tissues?
- A. Chitin
  - B. Cellulose
  - C. Hyaluronate
  - D. Peptidoglycan
  - E. None of the above
13. Which of the following monosaccharides is a carboxylic acid?
- A. Fructose
  - B. Glucuronate
  - C. Maltose
  - D. Glucose
  - E. None of the above
14. During transfer of two electrons through the mitochondrial respiratory chain, the overall reaction is:
- $$\text{NADH} + 1/2 \text{O}_2 + \text{H}^+ \longrightarrow \text{NAD}^+ + \text{H}_2\text{O}$$
- For this reaction, the difference in reduction potentials for the two half-reactions ( $\Delta E'^{\circ}$ ) is +1.14 V. What is the standard free-energy change,  $\Delta G'^{\circ}$ , for the reaction. (The Faraday constant, **F**, is 96.48 kJ/V·mol.)
- A. -110 kJ/mol
  - B. -220 kJ/mol
  - C. +110 kJ/mol
  - D. +220 kJ/mol
  - E. None of the above
15. Which one of the following compounds has a large negative free energy of hydrolysis?
- A. Sucrose
  - B. 3-Phosphoglycerate
  - C. Phosphoenolpyruvate
  - D. AMP
  - E. None of the above

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16. Which one of the following reactions of the citric acid cycle produces an ATP equivalent (in the form of GTP) by substrate level phosphorylation?
- A. Citrate to isocitrate.
  - B. Fumarate to malate.
  - C. Malate to oxaloacetate.
  - D. Succinyl-CoA to succinate.
  - E. none of the above.
17. Which one of the following enzymes acts on two  $O_2^-$ , converting them to one molecule of water and one molecule of  $H_2O_2$ .
- A. Superoxide dismutase
  - B. Glutathione peroxidase
  - C. Glutathione reductase
  - D. Nicotinamide nucleotide transhydrogenase
  - E. None of the above
18. If intact mitochondria were incubated with antimycin A, excess NADH, and an adequate supply of  $O_2$ , which of the following would be found in the oxidized state?
- A. Coenzyme Q
  - B. Cytochrome *b*
  - C. Cytochrome *a3*
  - D. Cytochrome *e*
  - E. None of the above

三、簡答題與問答題 (7 題，共 69 分)

19. What is "facultative anaerobe"? (5%). For example, *E. coli* is a facultative anaerobic organism. Please describe in detail about the changes of total metabolites (10%) and energy metabolism (10%) of a *E. coli* cell with a null mutation in the gene encoded for the succinate dehydrogenase.
20. Please describe the mechanism of 5-fluorocytosine serving as an antifungal agent. (10%)
21. Allopurinol has been used to treat gouty arthritis, please describe its mechanism in detail. (5%)

(背面仍有題目,請繼續作答)

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22. Coffee is a brewed beverage with a distinct aroma and flavor prepared from the roasted seeds of the *Coffea* plant. The seeds are found in coffee "cherries", which grow on trees cultivated in over 70 countries, primarily in equatorial Latin America, Southeast Asia, South Asia and Africa. Coffee ingestion on average is about a third of that of tap water in North America and Europe. Behind petroleum, coffee is the second most traded product in the world. One of the world's primary sources of caffeine is the coffee "bean", from which coffee is brewed. Caffeine content in coffee varies widely depending on the type of coffee bean and the method of preparation used; even beans within a given bush can show variations in concentration. In general, one serving of coffee ranges from 80–100 milligrams, for a single shot (30 milliliters) of arabica-variety espresso, to approximately 100–125 milligrams for a cup (120 milliliters) of drip coffee. Caffeine is a bitter, white crystalline xanthine alkaloid synthesized from the purine nucleotides AMP, GMP, and IMP in plants. These in turn are transformed into xanthosine and then theobromine, the latter being the penultimate precursor of caffeine. Some diseases are affected by daily drinking of coffee. Please describe those diseases and their mechanisms in detail. (10%)
23. A) What is the effect of pH on the binding of oxygen to hemoglobin (the Bohr Effect)? (B) Briefly describe the mechanism of this effect. (C) What are other factors contributing to a similar effect? (5%)
24. Please explain why the muscles of a person are soft and relax during his sleeping, but stiff and tight when he is dead? (4%)
25. In three tubes each containing 25 mmole of enzyme A dissolved in 100 ml of an appropriate buffer (pH 7.4), 4 mM, 10 mM, or 30 mM of the specific substrate (molecular weight= 100 dalton) could be converted into 1 mM, 2 mM, or 2 mM, respectively, of products per second. For this catalytic reaction: What are the  $V_{max}$  (mmole/sec);  $K_m$  (mM); and the  $K_3$  ( $\text{sec}^{-1}$ )? (10%)

*Hint-----  $K_3$  is the turnover number: the maximal number of moles (or molecules) of substrate transformed to products per mole (or molecule) of enzyme in a second*