

※ 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。

**Part I (25 points):**

Multiple Choice Questions

1. (1 point) Which enzyme is not involved in redistributing membrane lipids?

- A. Floppase
- B. Flippase
- C. Phospholipase
- D. Scramblase
- E. Phosphorylase

2. (1 point) Which one does not need ATP as energy for their functions?

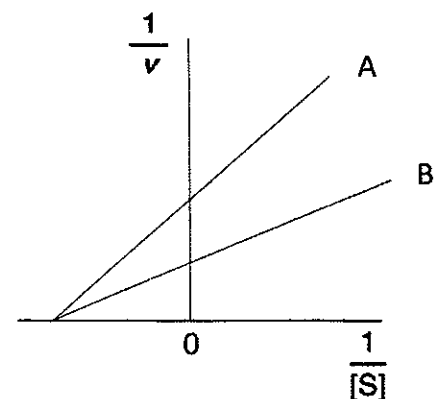
- A. ABC transporters
- B. Halorhodopsin
- C. Potassium channel
- D.  $\text{Na}^+$ ,  $\text{K}^+$  ATPase
- E. Proton pumps

3. The Lineweaver-Burt plot below showing line A for enzyme X with inhibitors, and line B for enzyme X only.

A. (1 point) What types are these inhibitors? (Hints: competitive, noncompetitive, mixed or uncompetitive?)

B. (1 point) Can we reverse the inhibition if we add more substrates to the reaction?

(1 point) Why?



4. Please briefly explain the following terms.

- A. (1 point) Ribozymes
- B. (1 point) cAMP
- C. (1 point) Phosphatase
- D. (1 point) Phosphorylase

5. We are going to do site-directed mutagenesis to alter some amino acid residues on Chymotrypsin, if we
- A. (1 point) change Ser195 to be Gly in the active site, will that affect the enzyme activity?
  - B. (1 point) change His57 to be Gly in the active site, will that affect the enzyme activity?
  - C. (1 point) change Asp102 to be Glu in the active site, will that affect the enzyme activity?
6. (1 point) In eukaryotic cells, glycolysis occurs in the \_\_\_\_\_, and the TCA cycle reactions take place in \_\_\_\_\_.
- A. mitochondria; mitochondria
  - B. cytoplasm; mitochondria
  - C. cytoplasm; cytoplasm
  - D. mitochondria; ribosomes
  - E. cytoplasm; ribosomes
7. (1 point) In the TCA cycle, carbon enters the cycle as \_\_\_\_\_ and exits as \_\_\_\_\_ with metabolic energy captured as \_\_\_\_\_, \_\_\_\_\_ and \_\_\_\_\_.
- A. malonate; water; NADH; ATP; NADPH
  - B. acetyl-CoA; CO<sub>2</sub>; NADH; ATP; NADPH
  - C. succinyl-CoA; CO<sub>2</sub>; ATP; NADH; NADPH
  - D. acetyl-CoA; CO<sub>2</sub>; ATP; NADH; FADH<sub>2</sub>
  - E. malonyl-CoA; water; NADH; FADH<sub>2</sub>; ATP
8. (1 point) Mammalian pyruvate dehydrogenase is regulated by phosphorylation using the enzyme \_\_\_\_\_ which is allosterically activated by high levels of \_\_\_\_\_ and \_\_\_\_\_.
- A. pyruvate kinase; ATP; acetyl-CoA
  - B. pyruvate kinase; NADH; NADPH
  - C. pyruvate carboxylase; acetyl-CoA; ATP
  - D. pyruvate dehydrogenase kinase; NADH; acetyl-CoA
  - E. pyruvate dehydrogenase kinase; ADP; NAD<sup>+</sup>
9. (1 point) Inhibition of the citric acid cycle at isocitrate dehydrogenase increases the levels of citrate and isocitrate that may increase the production of:
- A. amino acids.
  - B. pyruvate and oxaloacetate.
  - C. glyoxylate and cytosolic acetyl-CoA.
  - D. succinate and fumarate.
  - E.  $\alpha$ -ketoglutarate and succinyl-CoA

10. (1 point) The oxidation of malate to oxaloacetate is not thermodynamically favored under standard conditions. It occurs because:
- A. it involves substrate-level phosphorylation.
  - B. it is coupled with a strong reduction.
  - C. it is coupled with ATP hydrolysis.
  - D. oxaloacetate is used in the next reaction, which has a negative  $\Delta G$ .
  - E. the previous reaction has a large negative  $\Delta G$ .
11. (1 point) All are correct statements about the reaction catalyzed by citrate synthase EXCEPT:
- A. Citrate synthase is allosterically activated by ATP.
  - B. The complete chemical equation is:  
$$\text{Oxaloacetate} + \text{acetyl-CoA} + \text{H}_2\text{O} \rightarrow \text{citrate} + \text{CoA}$$
  - C. Citryl-CoA is formed as an intermediate.
  - D. The mechanism involves attack of the carbanion of acetyl-CoA on the carbonyl carbon of oxaloacetate.
  - E. The enzyme uses general base catalysis to generate the reactive species.
12. (1 point) All are characteristics of succinyl-CoA synthetase EXCEPT:
- A. succinyl-CoA can be used to drive phosphorylation of GDP or ADP.
  - B. the enzyme is named for the reverse reaction.
  - C. it provides an example of substrate-level phosphorylation.
  - D. succinyl-phosphate is an intermediate in the reaction catalyzed by succinyl-CoA synthetase.
  - E. all of the above are true.
13. (1 point) The succinate dehydrogenase mechanism involves the \_\_\_\_ of succinate, which is exergonic and can be used to provide for the \_\_\_\_.
- A. oxidation; reduction of  $\text{NAD}^+$
  - B. reduction; oxidation of  $\text{NAD}^+$
  - C. oxidation; reduction of [FAD]
  - D. reduction; oxidation of [FAD]
  - E. none are true
14. (1 point) Fumarase catalyzes a reaction for which each of the following is true EXCEPT:
- A. fumarate is hydrated
  - B. the reaction is stereospecific for a *trans* product
  - C. the reaction involved is similar to that carried out by aconitase
  - D. L-malate is the produced
  - E. all are true

15. (1 point) Which of the following correctly and completely describes electron movement in electron transport?
- A.  $\text{NADH} \rightarrow \text{complex I} \rightarrow \text{complex III} \rightarrow \text{coenzyme Q} \rightarrow \text{Complex IV} \rightarrow \text{O}_2$
  - B.  $[\text{FADH}_2] \rightarrow \text{complex II} \rightarrow \text{cytochrome c} \rightarrow \text{complex III} \rightarrow \text{coenzyme Q} \rightarrow \text{Complex IV} \rightarrow \text{O}_2$
  - C.  $\text{NADH} \rightarrow \text{complex I} \rightarrow \text{coenzyme Q} \rightarrow \text{complex III} \rightarrow \text{cytochrome c} \rightarrow \text{Complex IV} \rightarrow \text{O}_2$
  - D.  $[\text{FADH}_2] \rightarrow \text{complex I} \rightarrow \text{coenzyme Q} \rightarrow \text{complex III} \rightarrow \text{Complex IV} \rightarrow \text{O}_2$
  - E. none of the above
16. (1 point) Where does the energy that drives ATP synthesis come from?
- A. The proton gradient.
  - B.  $\text{NAD}^+$  and FAD.
  - C. The electron gradient.
  - D. The oxidation states of the complexes.
  - E. Molecular oxygen.
17. (1 point) Photosynthetic phosphorylation and oxidative phosphorylation are similar processes. All of the following are common to BOTH processes EXCEPT:
- A. both have fixed and mobile electron carriers.
  - B. both contain cytochromes in their electron carrier chains.
  - C. both produce NADPH to be used in the reductive pentose phosphate pathway (Calvin cycle).
  - D. both represent a major route of ATP synthesis.
  - E. both have quinones as electron carriers.
18. (1 point) During photosynthesis-linked carbohydrate synthesis in plants, the products of photosynthesis are required for the actual fixation of carbon. Which of the following correctly explains the use of the products of photosynthesis?
- A. NADPH is required for the actual reduction of  $\text{CO}_2$  by the RUBISCO enzyme.
  - B. ATP is used primarily during the regeneration of ribulose-1,5-bisphosphate.
  - C. Oxygen is used during the oxidation of glyceraldehyde-3-phosphate to 1,3-bisphosphoglycerate.
  - D. Protons from the formation of the proton gradient are required to activate the RUBISCO enzyme.
  - E. Both A and B are correct.
- Part II (25 points):**
19. (5 points) Why do proteins fold faster *in vivo* than *in vitro*?
20. (5 points) Compare and contrast the structures of proteins and polysaccharides.
21. (5 points) Humans who receive transplants of animal tissues reject the transplanted tissue within minutes. In order to circumvent this problem, “transplant friendly” pigs have been engineered. Explain why humans reject normal animal tissue and describe the modification that renders the pigs “transplant

friendly.”

22. (5 points) Catabolism is primarily an oxidative process. Write the glycolytic reaction that represents a metabolic oxidation. Name the enzyme that catalyzes this reaction, and identify the oxidizing agent of this reaction.
23. (5 points) The formation of oxaloacetate from pyruvate occurs only inside the mitochondrion, whereas the enzymes that convert phosphoenolpyruvic acid (PEP) to glucose are cytosolic. In humans, there is no membrane transport system for oxaloacetate. Discuss how oxaloacetate is transported out of the mitochondrion.

**Part III (50 points):**

Multiple Choice Questions

24. (1 point) Which of the following statements regarding the structure of DNA is correct?
- the two strands are parallel.
  - the two strands are held together by intrachain hydrogen bonds.
  - the two strands have complementary base pairing.
  - the hydrogen bonding that holds the helix together is always between two purines or between two pyrimidines.
  - the ratio of adenine to guanine is the same in all organisms.
25. (1 point) Prokaryotic chromosomes are typically \_\_\_\_, while eukaryotic chromosomes are \_\_\_\_
- circular; linear and richly protein-associated
  - circular and richly protein-associated; linear
  - linear and richly protein-associated; circular
  - linear; circular and richly protein-associated
  - none are true.
26. (1 point) Which of the following correctly describes tRNA molecules?
- each amino acid in proteins has at least three unique tRNA species dedicated to chauffeuring its delivery to ribosomes for insertion into growing polypeptides.
  - they are small molecules containing 73 or 74 bases.
  - they often contain bases such as inosine or pseudouridine
  - the 5' end of the molecule is the site of attachment for the amino acid
  - none of the above is correct

27. (1 point) \_\_\_\_ are important in the processing of eukaryotic gene transcripts into mature messenger RNAs for export from the nucleus into cytoplasm.
- snRNAs as snRNPs
  - tRNAs
  - rRNAs
  - siRNAs
  - stRNAs
28. (1 point) RNA is \_\_\_\_ stable to alkaline hydrolysis than DNA because RNA's vicinal \_\_\_\_ group makes the 3'-phosphodiester bond susceptible to \_\_\_\_ cleavage.
- less; 3'-OH; nucleophilic
  - less; 2'-OH; nucleophilic
  - more; 2'-OH; electrophilic
  - more; 2'-OH; nucleophilic
  - more; 3'-OH; electrophilic
29. (1 point) All are true for DNA polymerase EXCEPT:
- requires a primer with a free 5'-OH end, but the 3'-end may be phosphorylated.
  - copies the sequence of nucleotides of one strand to form a new second strand.
  - copies the sequence of nucleotides of one strand in a complementary fashion.
  - generates dsDNA from ssDNA
  - synthesizes new strands by adding successive nucleotides in the 5'→3' direction.
30. (1 point) What is the nucleotide sequence of the DNA strand that is complementary to 5'-ATCGCAACTGTCCTA-3'?
- 5'-TAGCGTTGACAGTGAT-3'
  - 5'-UAGUGACAGUUGCGAU-3'
  - 5'-TAGCGTTGACAGTGAT-3'
  - 5'-TAGTGACAGTTGCGAT-3'
  - 5'-ATCACTGTCAACGCTA-3'
31. (1 point) The higher the \_\_\_\_ content of a DNA, the \_\_\_\_ the melting temperature, and the \_\_\_\_ the ionic strength, the \_\_\_\_ the melting temperature.
- G:C; higher; higher; lower
  - G:C; lower; higher; lower
  - G:C; higher; lower; lower
  - A:T; higher; higher; lower
  - A:T; lower; lower; higher

32. (1 point) Which of the following enzymes introduces negative supercoils into DNA?
- DNA polymerase
  - DNA gyrase
  - DNA ligase
  - primase
  - DNA photolyase
33. (1 point) All of the following are true of transamination EXCEPT:
- It is characterized by the transfer of an  $\alpha$ -amino group from an amino acid to the  $\alpha$ -keto position of an  $\alpha$ -keto acid.
  - The amino donor becomes an  $\alpha$ -keto acid.
  - The coenzyme needed is thiamin pyrophosphate (TPP).
  - Humans are capable of synthesizing the  $\alpha$ -keto acid analog of nonessential amino acids and using transamination to form the amino acids, but are not able to construct carbon skeletons of the essential amino acids.
  - The  $\alpha$ -keto acid acceptor becomes an  $\alpha$ -amino acid.
34. (1 point) Glutamine synthetase plays an important role in the incorporation of ammonia (or ammonium ions) into glutamine. Which of the following mechanisms of covalent modification controls the activity of glutamine synthetase?
- Phosphorylation/dephosphorylation
  - Adenylation/deadenylation
  - Acetylation/deacetylation
  - Methylation/demethylation
  - None of the above
35. (1 point) Absorbed lipids are condensed with glycerol in the epithelial cells into \_\_\_\_\_ and re-packaged into \_\_\_\_\_ that are initially transported by the \_\_\_\_\_ system.
- phospholipids; VLDL; lymphatic
  - triacylglycerols; VLDL; portal
  - triacylglycerols; LDL; portal
  - triacylglycerols; chylomicron; lymphatic
  - triacylglycerols; VLDL; lymphatic

**Short Answer Questions:**

36. (6 points) Use lac operon as an example to describe and contrast positive regulation and negative regulation of gene expression.
37. (6 points) Describe the structure and action of insulin receptor.
38. (6 points) Describe the functions of E1, E2 and E3 during conjugation of an ubiquitin to its target.
39. (6 points) Describe and contrast the mechanisms to locate the initiation codon by prokaryote and eukaryote.
40. (6 points) Describe the processing of pre-mRNA into mature mRNA.
41. (6 points) Describe and contrast the difference between DNA replication and RNA transcription.
42. (2 points) What are ketone bodies?