

※ 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、配合題 (5分, 每題1分)

Choose the correct answer from the list. Not all the answers will be used.

- A. HDL
- B. propionyl-CoA
- C. LDL
- D. Dihydroxyacetone phosphate
- E. malonyl-CoA
- F. ACP
- G. chylomicrons
- H. phosphopantetheine
- I. flavin
- J. albumin
- K. ketone bodies
- L. cholesterol

1. Lipoproteins formed in the intestinal mucosal cells are called _____.
2. The glycerol backbone of triacylglycerols is catabolized to _____.
3. Free fatty acids bind to _____ for circulation in the bloodstream.
4. Acyl carrier protein (ACP) contains a _____ prosthetic group.
5. Fatty acid synthesis requires both acetyl-CoA and _____ as initiator molecules.

二、選擇題 (33分, 每題1分)

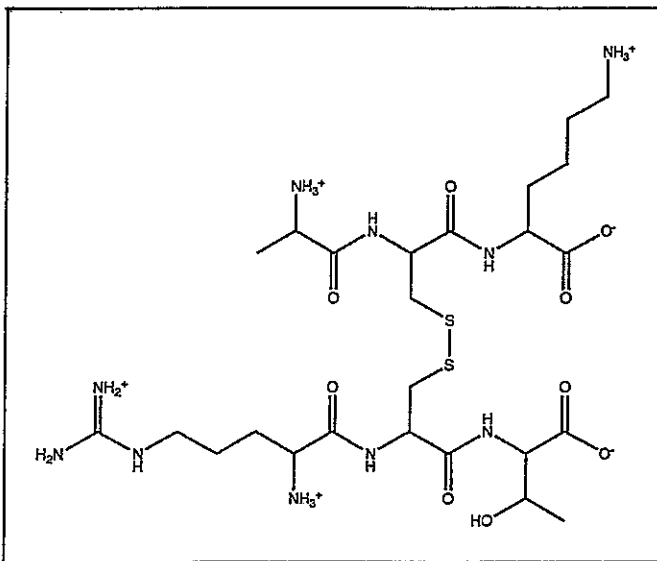
6. A thermodynamic pit occurs when
 - A. ES is highly stable.
 - B. ES is not very stable.
 - C. ES forms faster than it dissociates.
 - D. S is not bound tightly to an enzyme.
 - E. S is positioned incorrectly to the enzyme.

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7. Superoxide dismutase enzyme catalysis is faster than the rate of diffusion because it

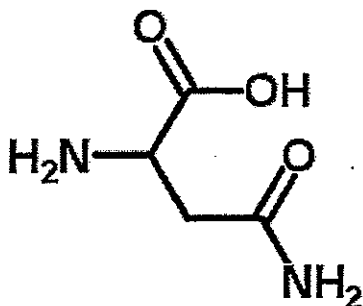
- A. is an acid-base catalyst.
- B. is a two-step reaction.
- C. has a hydrophobic interaction within active site
- D. occurs in very high quantities in cells.
- E. has an electric field around the active site.

8. How many amino acids in the following organic compound?



- A. 2
- B. 3
- C. 4
- D. 5
- E. 6

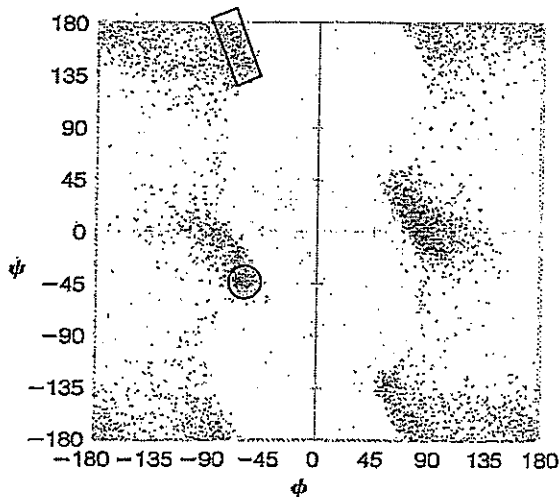
9. What amino acid is this structure?



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- A. K
- B. Q
- C. D
- D. N
- E. E

10. What are secondary structures covered by the rectangle and circle, respectively, in the following Ramachandran plots?

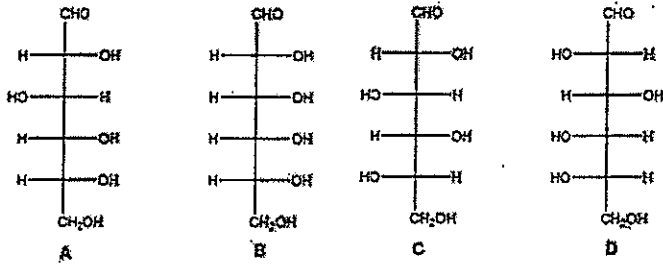


- A. Parallel β -sheet and right-handed α -helix.
 - B. Polypeptide II helix and right-handed α -helix.
 - C. Anti-parallel β -sheet and 3_{10} -helix.
 - D. Parallel β -sheet and left-handed α -helix.
 - E. Polypeptide II helix and left-handed α -helix.
11. Which of the following description about saccharides are correct?
- A. The deoxy sugars are monosaccharides in which a hydroxyl group is replaced with a hydrogen atom.
 - B. Bulky ring substituents preferentially occupy equatorial positions in the chair conformation.
 - C. Lactose is the disaccharide commonly found in dairy products.
 - D. Glycogen is a homopolysaccharide frequently found in liver and muscle.
 - E. All of the above.
12. Which sugar shown in the figure above is the enantiomer of sugar A? (圖請見上方第10題)
- A. B
 - B. C

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- C. D
- D. B and D
- E. none of the above

13. Which of the sugars shown in the figure below are L sugars?



- A. A and B
- B. B and C
- C. C and D
- D. A and D
- E. None of the above

14. Which two sugars shown in the figure above are epimers?

- A. A and B
- B. B and C
- C. C and D
- D. A and D
- E. None of the above

15. Which of these polysaccharides is a branched polymer?

- A. chitin
- B. amylose
- C. cellulose
- D. amylopectin
- E. hyaluronic acid

16. O-linked oligosaccharides are commonly attached to the —OH group of _____.

- A. ribose
- B. tyrosine
- C. lysine
- D. threonine
- E. glycine

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17. Which statement about *N*-linked glycosylation is correct?

- A. *N*-linked oligosaccharides are attached to proteins one sugar at the time in the endoplasmic reticulum.
- B. *N*-linked sugars are attached to proteins as a 14 residue oligosaccharide during translation in the endoplasmic reticulum.
- C. *N*-linked sugars are attached to proteins as a 14 residue oligosaccharide during translation in the cytoplasm.
- D. *N*-linked sugars are attached to proteins as a 14 residue oligosaccharide after translation in the Golgi apparatus.
- E. *N*-linked oligosaccharides are attached to proteins one sugar at the time in the Golgi apparatus.

18. Which amino acid at *N*-linked oligosaccharides can be covalently linked to proteins?

- A. Gly
- B. Ser
- C. Glu
- D. Tyr
- E. Asn

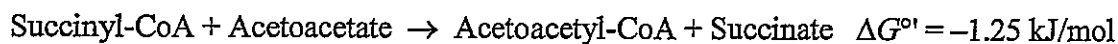
19. Which of the choices correctly ranks the following compounds from lowest level of oxidation to highest level of oxidation?

1	2	3
CH ₃ CHO	CH ₂ =CH ₂	CH ₃ CO ₂ H

- A. 1 < 2 < 3
- B. 2 < 1 < 3
- C. 1 < 3 < 2
- D. 3 < 2 < 1
- E. 2 < 3 < 1

20. Consider the following metabolic reactions:

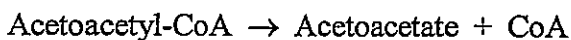
Reaction 1:



Reaction 2:

The ΔG° for the hydrolysis of Succinyl-CoA is -33.9 kJ/mol .

Reaction 3:



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What is the ΔG° for the hydrolysis of Acetoacetyl-CoA (Reaction 3)?

- A. -35.2 kJ/mol
- B. -32.7 kJ/mol
- C. $+32.7$ kJ/mol
- D. $+35.2$ kJ/mol
- E. none of the above.

21. In the Reaction 1 provided from question 20, the reaction $\Delta G^{\circ} = -1.25$ kJ/mol. Which of the following best describes this reaction?

- A. It is favorable under standard conditions.
- B. It is not favorable under standard conditions.
- C. It is nonspontaneous as written regardless of reactant concentrations
- D. It is spontaneous as written only when [succinate] and [acetoacetyl-CoA] are high.
- E. It is favorability of this reaction as written depends on temperature and reactant concentrations

22. In eukaryotes, glycolysis typically occurs in the

- A. mitochondrion.
- B. cytosol.
- C. lysosome.
- D. rough endoplasmic reticulum.
- E. smooth endoplasmic reticulum.

23. Which of the compound below is in the highest oxidation state?

- A. carbon monoxide
- B. carbon dioxide
- C. ethanol
- D. A, B, and C are equal
- E. A and B are equal

24. Glucose is converted to _____ in skeletal muscle under anaerobic conditions.

- A. lactate
- B. acetaldehyde
- C. fructose
- D. glycogen
- E. acetyl-CoA

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25. Aerobic glycolysis produces a net yield of _____ ATP.

- A. 1
- B. 2
- C. 3
- D. 4
- E. more than 4

26. Which of the following enzymes catalyzes the transfer of a phosphoryl group from ATP to glucose?

- A. hexokinase
- B. phosphoglucose isomerase
- C. glucose-6-phosphatase
- D. phosphoglucose mutase
- E. A transfer such as this does not occur in glycolysis.

27. Methanol is highly toxic, not because of its own activity, but because it is converted metabolically into formaldehyde, which is the actual poison. What enzyme catalyzes this conversion?

- A. methanol caboxylase
- B. methanol transferase
- C. alcohol transmutase
- D. alcohol carboxylase
- E. alcohol dehydrogenase

28. Which of the following citric acid cycle intermediates can be converted to aspartate via transamination?

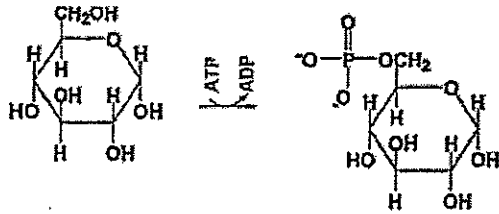
- A. citrate
- B. α -ketoglutarate
- C. succinate
- D. fumarate
- E. oxaloacetate

29. Which of the following reactions does not occur in mammals?

- A. $\text{pyruvate} + \text{NADH} \rightarrow \text{lactate} + \text{NAD}^+$
- B. $\text{ribulose-5-phosphoate} \rightarrow \text{ribose-5-phosphate}$
- C. $\text{mannose} + \text{ATP} \rightarrow \text{mannose-6-phosphate} + \text{ADP} + \text{P}_i$
- D. $6\text{-phophogluconate} + \text{NADP}^+ \rightarrow \text{ribulose-5-phosphate} + \text{NADPH} + \text{CO}_2$
- E. $\text{pyruvate} + \text{NADH} + \text{H}^+ \rightarrow \text{CO}_2 + \text{ethanol} + \text{NAD}^+$

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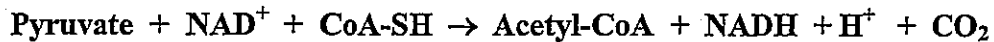
30. Select the enzyme from the list which would catalyze the reaction shown below.



- A. hexokinase (HK)
 - B. pyruvate kinase (PK)
 - C. enolase
 - D. phosphoglucomutase (PGM)
 - E. G3P dehydrogenase (G3PDH)
31. Which of the following is correct?
- A. Glucose can be synthesized from noncarbohydrate precursors by gluconeogenesis.
 - B. Low blood glucose (< 5mM) levels result in the release of glucagon.
 - C. NADPH used in lipid biosynthesis is produced by the pentose phosphate pathway.
 - D. The citric acid cycle is also called the Krebs cycle.
 - E. All of the above.
32. What is the net energetic cost of converting two pyruvate to one glucose by gluconeogenesis in ATP equivalents?
- A. 2
 - B. 3
 - C. 4
 - D. 6
 - E. 8
33. In eukaryotes, the citric acid cycle occurs in the _____ and therefore requires that reactants of the citric acid cycle be transported from the _____.
- A. cytosol; mitochondrial matrix
 - B. mitochondrial matrix; cytosol
 - C. endoplasmic reticulum; mitochondrial matrix
 - D. inner mitochondrial membrane; mitochondrial matrix
 - E. outer mitochondrial membrane; cytosol

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34. Which of the following is(are) TRUE concerning the metabolic reaction shown below?



- I. The enzyme that catalyzes this reaction contains a pyridoxal phosphate prosthetic group.
 - II. This reaction is an oxidative decarboxylation.
 - III. The enzyme that catalyzes this metabolic conversion is activated by high concentrations of ATP.
- A. I, II, III
 - B. II, III
 - C. II only
 - D. III only
 - E. I, II

35. Which of the following best describes the importance of the citric acid cycle as a central pathway of metabolism?

- A. It allows recovery of energy from carbohydrates only.
- B. It allows recovery of energy from fatty acids only.
- C. It allows recovery of energy from amino acids only.
- D. It allows recovery of energy from several metabolic fuels that are broken down to acetyl-CoA.
- E. Both A and B

36. An individual with a shortage of B vitamins (which include thiamine and riboflavin) may feel fatigued as a result of decreased pyruvate dehydrogenase activity. Which of the following would be TRUE regarding this shortage?

- A. The amount of acetyl CoA produced from carbohydrate metabolism that enters the citric acid cycle would be decreased.
- B. A decrease in the amount of NADH would likely decrease activity of citrate synthase.
- C. Flux through the citric acid cycle would cease until adequate pyruvate is available.
- D. none of the above
- E. all of the above

37. Which of the following is TRUE regarding heme proteins?

- I. Heme groups are capable of transferring electrons across large distances provided that some molecular network exists as a "path."
- II. Heme groups are often buried in protein structure because the protein protects the heme and prevents it from indiscriminately transferring electrons.
- III. The rate of electron transfer from a reduced heme is physiologically significant.
- IV. Heme groups are often differentiated by their absorption spectrum.

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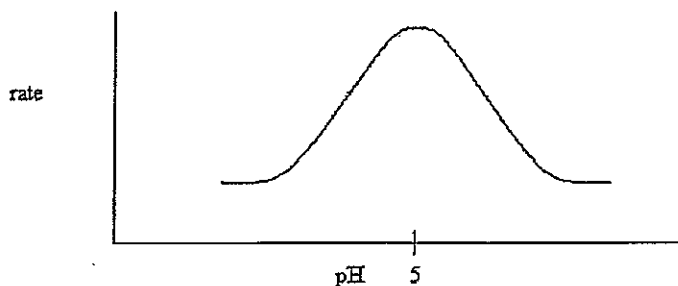
- A. I, III
- B. I, III, IV.
- C. I, II
- D. II, IV
- E. I, II, III, IV

38. All of the following inhibit electron transport EXCEPT

- A. oxaloacetate
- B. rotenone
- C. anitimycin A
- D. cyanide
- E. All of the above inhibit electron transport,

三、選擇題 (40分，每題2分)

39. The following pH dependence was found for the activity of a certain enzyme-catalyzed reaction.

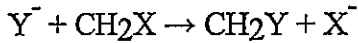


If it is known that the only two ionizable residues in the active site are both glutamates, which conclusion can be drawn?

1. The glutamates have different microenvironments which cause their pKa's to differ.
 2. One of the glutamates must be amidated.
 3. At pH 5, one glutamate is protonated and the other is not.
 4. At pH 2, one glutamate is deprotonated and the other is not.
 5. At pH 2, both glutamates are similarly ionized
- A. 1, 3, and 4
 - B. 1 and 3
 - C. 1 and 4
 - D. 2 only
 - E. 5 only

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40. In the reaction below, Y⁻ is _____.



1. the reaction intermediate
 2. attacking the nucleophile
 3. attacking the electrophile
 4. a nucleophile
 5. an electrophile
- A. 1 and 2
B. 2 and 3
C. 2 and 4
D. 3 and 4
E. 3 and 5

41. Aspartate and lysine are in the active site of an enzyme. They are both known to participate directly in catalysis. The pK_a's of the residues are found to be 3.2 and 9.6, respectively for aspartate and lysine. The optimum pH for the enzyme is 6.4. Which forms of these two residues will predominate when the enzyme is most active?

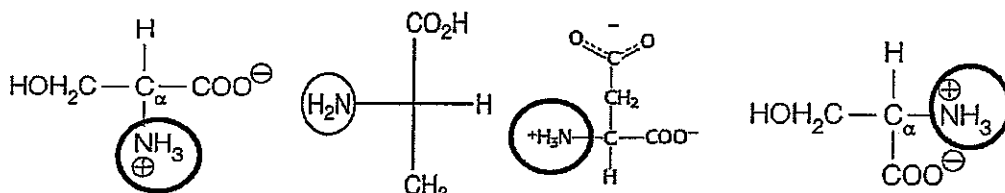
1. Aspartate is protonated; lysine is deprotonated.
 2. Both residues are ionized.
 3. Lysine is deprotonated; aspartate is protonated.
 4. Both residues are deprotonated.
- A. 1 only
B. 2 only
C. 1 and 2
D. 2 and 3
E. 4 only

42. Which of the statements about muscle contraction is correct?

1. During muscle contraction the sarcomere becomes shorter.
 2. During muscle contraction the I band becomes shorter.
 3. During muscle contraction the A band becomes longer.
 4. During muscle relaxation the distance between the Z disk and the M disk becomes longer.
 5. During muscle contraction calcium is released from ER to bind to Tropomyosin.
- A. 1, 2, 5
B. 2, 3, 4
C. 1, 2, 4
D. 1, 4
E. 1, 4, 5

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43. How many L-amino acids in the following structures?



- A. 0
- B. 1
- C. 2
- D. 3
- E. 4

44. A nonapeptide was determined to have the following amino acid composition: (Lys)₂, (Gly)₂, (Phe)₂, His, Leu, Met. The native peptide was incubated with 1-fluoro-2,4-dinitrobenzene (FDNB; R₁ = 1st amino acid from N-terminal) and then hydrolyzed; 2,4-dinitrophenylhistidine was identified by HPLC. When the native peptide was exposed to cyanogen bromide (CNBr), an octapeptide and free glycine were recovered. Incubation of the native peptide with trypsin (R₁ = R, K) gave a pentapeptide, a tripeptide, and free Lys. 2,4-Dinitrophenyl-histidine was recovered from the pentapeptide, and 2,4-dinitrophenylphenylalanine was recovered from the tripeptide. Digestion with the enzyme pepsin (R₂ = W, Y, F) produced a dipeptide, a tripeptide, and a tetrapeptide. The tetrapeptide was composed of (Lys)₂, Phe, and Gly. The native sequence was determined to be:

- A. His-Leu-Phe-Gly-Lys-Lys-Phe-Met-Gly.
- B. Gly-Phe-Lys-Lys-Gly-Leu-Met-Phe-His.
- C. His-Leu-Gly-Lys-Lys-Phe-Phe-Gly-Met.
- D. Met-Leu-Phe-Lys-Phe-Gly-Gly-Lys-His.
- E. His-Phe-Leu-Gly-Lys-Lys-Phe-Met-Gly.

45. Pauling and Corey's studies of the peptide bond showed that:

1. Peptide bonds in the polypeptides covalently stabilize 3-D structure.
2. Peptide bonds are essentially planar, with no rotation about the C—N axis.
3. No atoms should approach one another more closely than allowed by their entropic interactions.
4. Bond angles and lengths should be like those for respective free amino acids.
5. Primary structure of all proteins is similar, although the secondary and tertiary structure may differ greatly.

- A. 1, 2, 5
- B. 1, 2
- C. 2, 3, 5
- D. 2, 4
- E. 2, 3, 4

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46. Which of the followings are false about polypeptides?

1. The peptide bonds contribute to a Ramachandran plot.
2. Plane of rotation around the C_{α} —N bonds.
3. Regions of steric hindrance are determined by the large C=O groups and side chain R groups.
4. Absence of rotation around the C—N bond because of its partial double-bond character.
5. Theoretical space between -180 and $+180$ degrees can be occupied by the ϕ and ψ angles in the peptide bond.

- A. 2, 5
B. 3, 4
C. 1, 3
D. 4, 5
E. 1, 4

47. Which of the following statements concerning protein domains is(are) false?

1. They must be a form of secondary structure.
2. They may be closely located in one 3-D region of different polypeptides (subunits).
3. They may consist of distant regions within the same protein sequences.
4. They have been found only in eukaryotic proteins.
5. They may retain their correct shape even when separated from the rest of the protein.

- A. 1
B. 1, 4
C. 1, 3, 5
D. 1, 2, 4
E. 1, 4, 5

48. Which of the following explains why the ferrous ion is not oxidized to the ferric state in the globin proteins even though free heme in solution is readily oxidized?

- A. When bound to globins, the heme is always planar; when free in solution, heme adopts a non-planar configuration which allows the oxidation of the iron
- B. The globin proteins provide a hydrophobic environment that prevents oxidation
- C. Coordination with the proximal histidine allows any oxidized iron to be rapidly reduced back to the ferrous state
- D. Since the oxygen is hydrogen bound to the distal histidine, if oxidation of iron does occur, the distal histidine allows for rapid reduction
- E. None of the above

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49. Which of the following would result in a net increase in uptake of LDL by the liver?

- A. increased availability of LDL receptors
- B. high levels of cholesterol synthesis
- C. increased availability of clathrin triskelions
- D. all of the above
- E. none of the above

50. Which of the following is TRUE regarding the enzyme acetyl-CoA carboxylase?

- I. It catalyzes the first committed step in fatty acid oxidation.
 - II. It requires *S*-adenosylmethionine.
 - III. It produces malonyl CoA
 - IV. It uses acetyl CoA
- A. I, II, III, IV
 - B. I only
 - C. I, III, IV
 - D. III, IV
 - E. III only

51. Which of the following diets would most likely promote the formation of ketone bodies?

- A. high simple carbohydrates, low fat
- B. high complex carbohydrates, high fructose
- C. high fat, high protein, low carbohydrate
- D. low fat, high protein, high complex carbohydrates
- E. high fructose; high whole grain carbohydrates

52. Which of the following could be produced by the reaction of two or more of phosphatidic acids with two or more glycerol-3-phosphates?

- I. phosphatidylglycerol
 - II. cardiolipin
 - III. phosphatidylinositol
 - IV. gangliosides
- A. I, II, III, IV
 - B. II, III
 - C. I, III
 - D. I, II
 - E. III only

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53. Which of the following compounds is NOT derived from cholesterol?

- A. Glycocholate
- B. 1,25-dihydroxycholecalciferol
- C. α -tocopherol
- D. Aldosterone
- E. Cortisol

54. Which of the following produces the largest number of reducing equivalents when oxidized?

- A. Glucose
- B. NADPH
- C. NADH
- D. Palmitic acid
- E. A hydrogen atom

55. CDP-diglyceride is not involved in the biosynthesis of:

- A. phosphatidylcholine.
- B. phosphatidylethanolamine
- C. phosphatidylglycerol.
- D. phosphatidylserine.
- E. sphingomyelin.

56. Which of the following lipids have signaling functions?

- A. Triacylglycerols
- B. Steroids
- C. Bile salts
- D. Prostaglandins
- E. α -tocopherol

57. During its catabolism, propionyl-CoA is converted to the citric acid cycle intermediate _____.

- A. citric acid
- B. acetyl-CoA
- C. malonyl-CoA
- D. succinyl-CoA
- E. none of the above

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58. Drugs such as Lipitor control cholesterol levels by inhibiting:

- A. mevalonatase.
- B. HMG-CoA synthase.
- C. HMG-CoA reductase.
- D. mevalonate kinase.
- E. none of the above

四、簡答題（22 分，題分如題標示）

59. Most bacterial mutants that require isoleucine for growth also require valine. Why? Which enzyme or reaction would be defective in a mutant requiring only isoleucine (not valine) for growth? (5%)
60. Write out the series of reactions that are involved in the urea cycle in mammals and amphibians. Indicate the rate-determining step in the cycle. (4%)
61. Alkaptonuria (black urine disease, black bone disease, or alcaptonuria) is a rare inherited genetic disorder in which the body cannot process the amino acids phenylalanine and tyrosine. Please describe its biochemical pathway. (4%)
62. Please describe in detail about the mode of action for 5-fluorocytosine served as an antifungal agent. (4%)
63. Mario R. Capecchi, Martin J. Evans and Oliver Smithies were awarded as Nobel Laureates in Physiology or Medicine 2007 for their discoveries of "principles for introducing specific gene modifications in mice by the use of embryonic stem cells". For their initial experiments both Smithies and Capecchi chose a gene (hprt) that was easily identified. This gene is involved in a rare inherited human disease (Lesch-Nyhan syndrome). Capecchi refined the strategies for targeting genes and developed a new method (positive-negative selection) that could be generally applied. Please describe how does positive-negative selection work. (5%)