

※ 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 (9 分，每題 1 分)

1. Which of the following is not a ligand to the porphyrin ring Fe(II) ion in oxymyoglobin?
 - a). His E7
 - b). His F8
 - c). Nitrogen atoms in the porphyrin ring
 - d). Oxygen
 - e). all are ligands

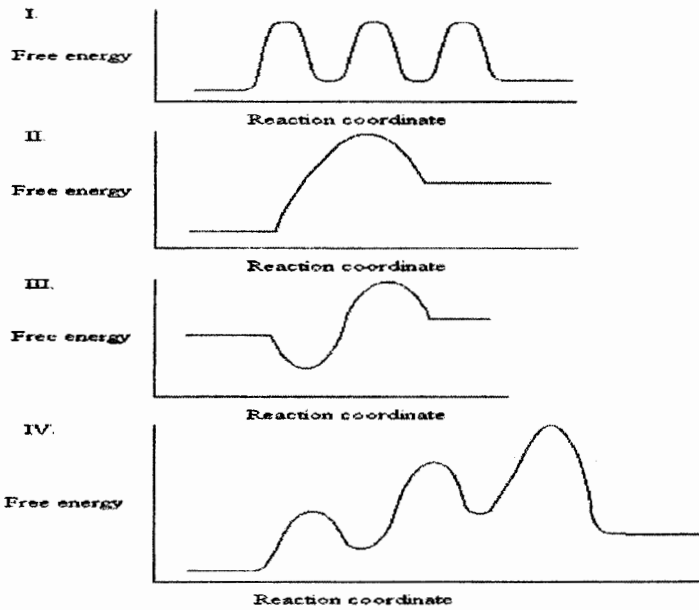
2. The primary structure of mammalian hemoglobin, an $\alpha_2\beta_2$ tetramer, is approximately _____ identical to myoglobin.
 - a). 2%
 - b). 18%
 - c). 50%
 - d). 78%
 - e). 98%

3. The Hill plot shows that the fourth oxygen binds to hemoglobin with a _____-fold greater affinity than the first.
 - a). 2
 - b). 5
 - c). 10
 - d). 20
 - e). 100

4. In sickle-cell anemia, the negatively charged glutamic acid residue is replaced by the neutral amino acid _____.
 - a). tryptophan
 - b). isoleucine
 - c). valine
 - d). alanine
 - e). leucine

5. Treadmilling refers to
- myosin heads walking along actin microfilaments.
 - actin and myosin filaments sliding along each other.
 - actin monomers moving through a microfilament from the + end to the - end.
 - synthesis and degradation of actin monomers.
 - the interactions between actin and tropomyosin.
6. Which of the following antibody-mediated autoimmune diseases targeting the connective tissues:
- Graves' disease
 - Myasthenia gravis
 - Rheumatoid arthritis
 - Systemic lupus erythematosus
 - Becher muscular dystrophy
7. Replacement of the amino acid _____ at or near an active site of an enzyme is more likely to change enzyme activity than the replacement of _____ at or near the active site.
- histidine; leucine
 - leucine; histidine
 - leucine; isoleucine
 - histidine; aspartate
 - serine; histidine
8. Histidine is an ideal amino acid at neutral pH values at the active site of many enzymes because
- it is hydrophobic.
 - it engages in electron transfer.
 - it is not ionizable.
 - its R group has a pKa of about 6 to 7 in most proteins.
 - its R group is structurally rigid.

9. The graphs below all represent the same chemical reaction, but each employing a different catalyst. Which enzyme uses the most efficient mechanism of catalysis?



- See Graph I.
- See Graph II.
- See Graph III.
- See Graph IV.
- See Graph I and IV.

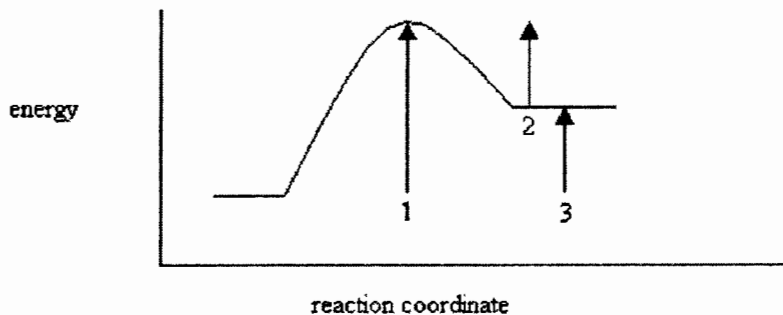
二、選擇題 (80 分，每題 2 分)

10. Consider a hypothetical hemoglobin-like molecule with a Hill coefficient (constant) of 1 and the same p_{50} value as normal hemoglobin. Choose the statement below that best describes the two proteins.
- There is a cooperative interaction between oxygen-binding sites in both the hypothetical and normal hemoglobins.
 - The hypothetical hemoglobin has a greater oxygen affinity than normal hemoglobin.
 - The oxygen binding curve for the hypothetical hemoglobin is hyperbolic, and the curve for normal hemoglobin is sigmoidal.
 - The two hemoglobins would be able to deliver about the same amount of oxygen to the tissues.
 - At pO_2 less than p_{50} , normal hemoglobin has a greater Y_{O_2} value.

11. The Bohr effect refers to
- the decrease in affinity of Hb for O₂ when the pH goes down
 - the decrease in affinity of Hb for O₂ when the pH goes up
 - the increase in the affinity of Hb for O₂ when the O₂ concentration goes up
 - the decrease in affinity of Hb for O₂ when the BPG concentration goes up
 - the decrease in affinity of Hb for O₂ when the BPG concentration goes down
12. Why is the decreased affinity of fetal hemoglobin for BPG advantageous?
- With fewer BPG molecules bound there are more heme residues available for O₂ binding.
 - Decreased BPG binding biases the fetal hemoglobin toward the R state.
 - More free BPG is available to bind to adult hemoglobin, resulting in a shift to the R state.
 - BPG is available to bind to fetal myoglobin, helping to release O₂ in fetal muscle tissue.
 - none of the above
13. Which of the statements about muscle contraction is not true?
- During muscle contraction the sarcomere becomes shorter.
 - During muscle contraction the I band becomes shorter.
 - During muscle contraction the H zone becomes shorter.
 - During muscle contraction the A band becomes shorter
 - During muscle contraction the distance between the Z disk and the M disk becomes shorter.
14. The loss of tolerance to one's own antigens may result from:
- an innate malfunctioning of the mechanism by which the immune system distinguishes humoral immunity from cellular immunity
 - tissues that are normally exposed from the immune system are sequestered to lymphocytes B cells
 - injuries that breach the blood-brain barrier
 - antibodies against certain viral antigens that cross-react with bacterial antigens
 - generalized breakdown of the immune system, so that antibodies are inefficient to many endogenous substances
15. Antibodies recognize a huge variety of antigens because:
- the cellular immune system has the potential to produce a large number of different antibodies
 - the diversity in antibody sequences arises instead from genetic changes during B lymphocyte development
 - the number of immunoglobulin genes is far too large

- d). as the antibody-producing B cells become memory B cells, their rate of immunoglobulin gene mutation increases dramatically
- e). an individual can synthesize a large fraction of its potential immunoglobulin repertoire during its early embryonic development

16. On the energy diagram below, which arrow(s) represent the activation energy for the forward and reverse reactions?



- a). Arrow 1 is the activation energy for both the forward and reverse reactions.
 - b). Arrow 1 is the activation energy for the forward reaction and arrow 2 is the activation energy for the reverse reaction.
 - c). Arrow 1 is the activation energy for the forward reaction and arrow 3 is the activation energy for the reverse reaction.
 - d). Arrow 3 is the activation energy for the forward reaction and arrow 2 is the activation energy for the reverse reaction.
 - e). Arrow 2 is the activation energy for both the forward and reverse reactions.
17. Aspartate and lysine are in the active site of an enzyme. They are both known to participate directly in catalysis. The pKa'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?
- a). Aspartate is protonated; lysine is deprotonated.
 - b). Both residues are protonated.
 - c). Aspartate is deprotonated; lysine is protonated.
 - d). Both residues are deprotonated.
 - e). All of the above are correct
18. In glycoproteins, the carbohydrate moiety is always attached through the amino acid residues:
- a). asparagine, serine, or threonine.
 - b). aspartate or glutamate.

- c). glutamine or arginine.
 - d). glycine, alanine, or aspartate.
 - e). tryptophan, aspartate, or cysteine.
19. Which of the following is not an intermediate of the citric acid cycle?
- a). Acetyl-CoA
 - b). Citrate
 - c). Oxaloacetate
 - d). Succinyl-CoA
 - e). α -Ketoglutarate
20. Which of the following statements about starch and glycogen is false?
- a). Amylose is unbranched; amylopectin and glycogen contain several ($\alpha 1 \rightarrow 6$) branches.
 - b). Both starch and glycogen are homopolymers of glucose.
 - c). Both starch and glycogen serve primarily as structural elements in cell walls.
 - d). Both starch and glycogen are stored intracellularly as insoluble granules.
 - e). Glycogen is more extensively branched than starch.
21. Which of the following statements concerning the structure of the repeating basic unit of amylose and cellulose is correct?
- a). For the structure of amylose, the repeating unit is α -D-glucose linked to α -D-glucose.
 - b). For the structure of cellulose, the repeating unit is α -D-glucose linked to β -D-glucose.
 - c). The glycosidic bond in amylose is (β -1 \rightarrow 4).
 - d). The glycosidic bond in cellulose is (α -1 \rightarrow 4).
 - e). None of the above.
22. The energy yield in molecules of ATP per glucose monomer converted to lactate from glycogen via glycogen breakdown and glycolysis is
- a). 0 ATP.
 - b). 1 ATP.
 - c). 2 ATP.
 - d). 3 ATP.
 - e). 4 ATP.
23. The first reaction in glycolysis that results in the formation of an energy-rich compound is catalyzed by:
- a). hexokinase.
 - b). glyceraldehyde 3-phosphate dehydrogenase.

- c). phosphofructokinase-1.
 - d). phosphoglycerate kinase.
 - e). triose phosphate isomerase.
24. An enzyme used in glycolysis but not in gluconeogenesis is:
- a). 3-phosphoglycerate kinase.
 - b). glucose 6-phosphatase.
 - c). aldolase.
 - d). phosphofructokinase-1.
 - e). enolase.
25. Which of the following statements concerning the pentose phosphate pathway is correct?
- a). It generates CO_2 from C-1 of glucose.
 - b). It requires the participation of molecular oxygen.
 - c). It is not prominent in lactating mammary glands.
 - d). It is principally directed toward the generation of NADP^+ .
 - e). None of the above.
26. Glycogenin:
- a). catalyzes the conversion of glycogen into glucose.
 - b). is the enzyme that transfers a glucose residue from UDP-glucose to the hydroxyl group of a tyrosine residue on glycogenin molecule.
 - c). is responsible for forming branches in glycogen.
 - d). is the regulatory enzyme of glycogen synthesis.
 - e). none of the above.
27. In the citric acid cycle, all of the following enzymes require NAD^+ as a coenzyme *except* the reaction catalyzed by:
- a). isocitrate dehydrogenase.
 - b). malate dehydrogenase.
 - c). α -Ketoglutarate dehydrogenase.
 - d). succinate dehydrogenase.
 - e). none of the above.
28. Which 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.

29. 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.

30. Which of the following is required for entry of fatty acids into the oxidation pathway?

- I. priming via the enzyme acyl CoA synthetase
- II. conservation of free energy from ATP hydrolysis by use of a thioester linkage
- III. transport to the cytosol for oxidation via a carnitine carrier protein
- IV. hydrolysis of carnitine palmitoyl transfer protein

- a). I, II
- b). I, II, III
- c). I, II, III, IV
- d). III, IV
- e). I, III

31. Which of the following statements about peroxisomes is FALSE?

- a). β oxidation in peroxisomes can shorten very long fatty acids.
- b). Mammalian peroxisomes can synthesize some lipids, including bile salts.
- c). In plants, peroxisomes and glyoxysomes serve as the site of β oxidation.
- d). Long chain fatty acids are transported into the peroxisome via a carnitine carrier protein where they are activated for oxidation.
- e). β oxidation in peroxisomes varies slightly from the mitochondrial process.

32. Cholesterol is a precursor to

- I. prostaglandins
- II. vitamin K
- III. steroid hormones such as androgens
- IV. bile acids

- a). I, III, IV
- b). I, II, III, IV
- c). III only
- d). IV only
- e). III, IV

33. Sphinganine is an intermediate in the synthesis of which of the following?

- I. ceramides
- II. spingomyelins
- III. cerebrosides
- IV. prostaglandins

- a). I only
- b). I, II
- c). I, II, III
- d). II, III
- e). I, II, IV

34. 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

35. 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

36. Which of the following is true about membrane proteins embedded within the lipid bilayer?

- a). An increased temperature of the bilayer decreases the rate of transverse diffusion of the membrane protein.
- b). They undergo transverse diffusion approximately every 5 seconds at body temperature.
- c). They undergo transverse diffusion readily at body temperature unless their movement is restricted by other cellular components.
- d). As the temperature decreases, lateral diffusion of the membrane protein is restricted in bilayers with lipids which have longer chain fatty acids and fewer double bonds.
- e). Lateral diffusion of the membrane protein occurs independent of bilayer composition and temperature.

37. Which of the following lipids would NOT likely be found in a lipid raft?

- I. glycosphingolipids
- II. glycerophospholipids
- III. cholesterol
- IV. palmitoleic acid

- a). I, IV
- b). I, II, IV
- c). II, IV
- d). III, IV
- e). IV

38. Which of the following occurs during starvation?

- I. The kidney generates approximately half the glucose required for the body.
- II. The brain utilizes ketone bodies as a fuel source.
- III. The adipose tissue releases fatty acids.
- IV. Gluconeogenesis occurs in the liver.

- a). I, II, III, IV
- b). I, II, III
- c). I, II
- d). II, III
- e). II, III, IV

39. Which of the following metabolizes ketone bodies?

- I. brain
- II. liver
- III. muscle
- IV. adipose tissue

- a). I, II, III, IV
- b). I, II, III
- c). I, III
- d). II only
- e). III only

40. Which of the following vitamins is part of the prosthetic group 5'-deoxyadenosylcobalamin?

- a). B₁
- b). B₂
- c). B₆
- d). B₁₂
- e). none of the above

41. Which statement concerning phospholipid synthesis is true?

- a). Addition of polar "head groups" to diacylglycerol usually involves CDP derivatives.
- b). Addition of polar "head groups" to diacylglycerol usually involves UDP adducts.
- c). Addition of fatty acyl "tails" to glycerol usually involves CDP adducts.
- d). Addition of fatty acyl "tails" to glycerol usually involves UDP adducts.
- e). None of the above is true.

42. The amino acids Arg, His, Pro are all degraded to the metabolic intermediate _____ and are considered _____.

- a). fumarate ; glucogenic
- b). succinyl-CoA; ketogenic
- c). α -ketoglutarate ; glucogenic

- d). oxaloacetate ; ketogenic
e). acetoacetyl-CoA; ketogenic
43. A number of neurotransmitters are synthesized from amino acids by decarboxylations. The amino acid decarboxylases usually use _____ as a cofactor.
- a). thiamine pyrophosphate
b). biotin
c). pyridoxal-5'-phosphate
d). cobalt containing compounds [vitamin B₁₂]
e). tetrahydrofolate
44. _____ catalyzes the synthesis of _____, a molecule that signals vasodilatation, from the precursor _____
- a). Nitric oxide synthase; nitric oxide (NO); arginine
b). Nitrous oxidase; nitrous oxide; arginine
c). Arginase; nitric oxide (NO); citrulline
d). Citrulline dehydrogenase; nitrous oxide; citrulline
e). Ornithine transcarbamoylase; nitric oxide ; ornithine
45. Which of the following statements of oxidative deamination of glutamate in mammals is correct?
- I. The reaction generates NAD(P)H and α -ketoglutarate.
II. The enzyme that catalyzes the reaction is located in the mitochondria.
III. The reaction generates free NH_4^+ .
IV. The reaction eliminates the keto group from α -ketoglutarate.
- a). I only
b). I, II only
c). II, III, IV
d). I, II, III
e). III, IV only
46. Which of the following statements about maple syrup urine disease is **FALSE**?
- I. It is caused by a genetic deficiency in the enzyme branched-chain keto acid dehydrogenase.
II. The disease usually is relatively harmless.
III. There is a buildup of the branched-chain α -keto acids.
IV. Patients with the disease excrete urine that turns dark on standing as the metabolites are oxidized.

- a). I only
- b). II only
- c). III only
- d). II, IV
- e). I, III

47. Which of the following describes the sequential steps required prior to protein degradation by proteasome?

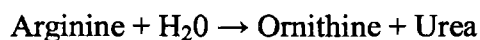
- I. Ubiquitin is transferred to a cysteine on a ubiquitin-conjugating enzyme.
- II. Ubiquitin is attached via a thioester to a ubiquitin-activating enzyme.
- III. The protein is linked to at least four tandemly linked ubiquitin units.
- IV. Activated ubiquitin is transferred to a lysine of the previously bound protein.

- a). I, II, III, IV
- b). IV, I, III, II
- c). II, I, IV, III
- d). I, II, I, III
- e). IV, II, III, I

48. Which of the following are nonessential amino acids for adult humans?

- a). Glu, Pro, Arg, Ala
- b). Arg, His, Gly, Met
- c). Met, Lys, His, Val
- d). Arg, Val, Thr, Ser
- e). Phe, Arg, Cys, Ser

49. In which cellular location does the following reaction take place in mammals?



- a). mitochondrial matrix
- b). cytosol
- c). lysosome
- d). nucleus
- e). endoplasmic reticulum

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三、問答題 (11 分)

50. A 10 year-old girl with mental retardation and compulsive self-injurious behavior has been diagnosed as suffering from Lesch-Nyhan syndrome which normally occurred in boys. Please describe the biochemical and molecular mechanisms of her disease and possible etiological phenotypes. (6%)
51. Please describe in detail about the mode of action for 5-fluorouracil and methotrexate served as chemotherapeutic agents for cancer. (5%)