國立成功大學 105 學年度碩士班招生考試試題

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考試科目：生物化學

考試日期：0228，節次：1

※ 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、是非題（5分，每題1分）

Q1-5: Consider a liver cell carrying out the oxidation of glucose under aerobic conditions. Suppose that we added a very potent and specific inhibitor of the mitochondrial ATP synthase, completely inhibiting this enzyme. Indicate whether each of the following statements about the effect of this inhibitor is "true" or "false"

1. _____ ATP production in the cell will quickly drop to zero.
2. _____ The rate of glucose consumption by this cell will decrease sharply.
3. _____ The rate of oxygen consumption will increase.
4. _____ The citric acid cycle will speed up to compensate.
5. _____ The cell will switch to fatty acid oxidation as an alternative to glucose oxidation, and the inhibitor will therefore have no effect on ATP production.

二、選擇題（15 分，每題 1 分）

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

7. 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.
   a). There is a cooperative interaction between oxygen-binding sites in both the hypothetical and normal hemoglobins.
   b). The hypothetical hemoglobin has a greater oxygen affinity than normal hemoglobin.
   c). The oxygen binding curve for the hypothetical hemoglobin is hyperbolic, and the curve for normal hemoglobin is sigmoidal.
   d). The two hemoglobins would be able to deliver about the same amount of oxygen to the tissues.
   e). At pO_2 less than p_{50}, normal hemoglobin has a greater Y_{O2} (θ) value.

8. 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

9. The Bohr effect refers to

a). the increase in the affinity of Hb for O_2 when the CO_2 concentration goes up
b). the decrease in the affinity of Hb for O_2 when the pH goes up
c). the decrease in the affinity of Hb for O_2 when the pH goes down
d). the decrease in the affinity of Hb for O_2 when the CO_2 concentration goes down
e). the increase in the affinity of Hb for BPG when the CO_2 concentration goes down

10. Why is the decreased affinity of fetal hemoglobin for BPG advantageous?

a). Decreased BPG binding biases the fetal hemoglobin toward the R state.
b). With fewer BPG molecules bound there are more heme residues available for O_2 binding.
c). More free BPG is available to bind to adult hemoglobin, resulting in a shift to the R state.
d). BPG is available to bind to fetal myoglobin, helping to release O_2 in fetal muscle tissue.
e). none of the above

11. Which of the statements about muscle contraction is <u>not</u> true?

a). During muscle contraction the sarcomere becomes shorter.
b). During muscle contraction the I band becomes shorter.
c). During muscle contraction the H zone becomes shorter.
d). During muscle contraction the A band becomes shorter
e). During muscle contraction the distance between the Z disk and the M disk becomes shorter.

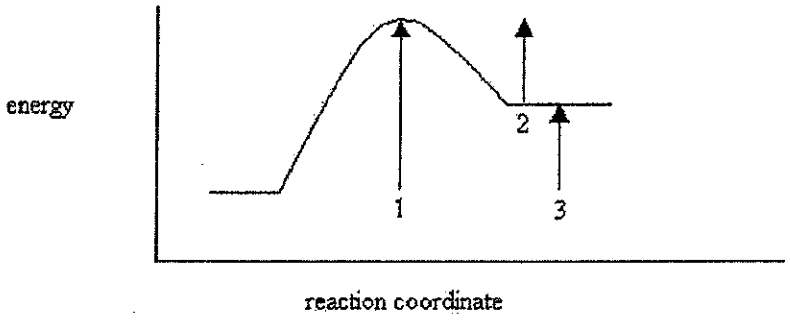
12. Which of the statements about muscle contraction is correct?

a). During muscle contraction the sarcomere becomes shorter.
b). During muscle contraction the I band becomes shorter.
c). During muscle contraction the H zone becomes shorter.
d). During muscle contraction the distance between the Z disk and the M disk becomes shorter.
e). All of the answers above are correct.

13. The loss of tolerance to one's own antigens may result from:

a). an innate malfunctioning of the mechanism by which the immune system distinguishes humoral immunity from cellular immunity
b). tissues that are normally exposed from the immune system are sequestered to lymphocytes B cells
c). injuries that breach the blood–brain barrier
d). antibodies against certain viral antigens that cross-react with bacterial antigens
e). generalized breakdown of the immune system, so that antibodies are inefficient to many endogenous substances

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

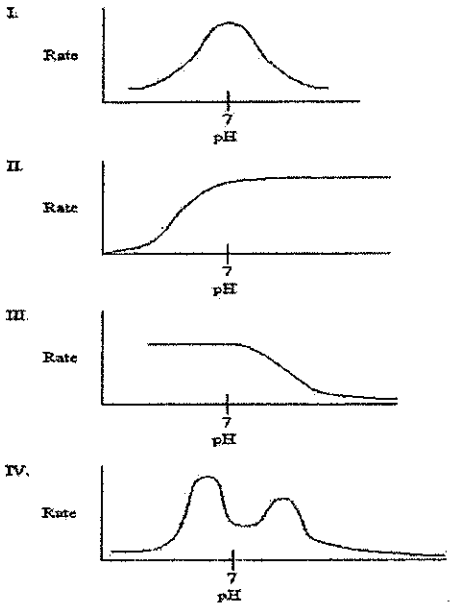


a). Arrow 1 is the activation energy for both the forward and reverse reactions.
b). Arrow 1 is the activation energy for the forward reaction and arrow 2 is the activation energy for the reverse reaction.
c). Arrow 1 is the activation energy for the forward reaction and arrow 3 is the activation energy 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.

15. 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). None of the above is correct.

16. Which graph might you expect for the pH profile of an enzyme's activity if the only ionizable residue in the active site is aspartate?



a). I
b). II
c). III
d). IV
e). either II or III

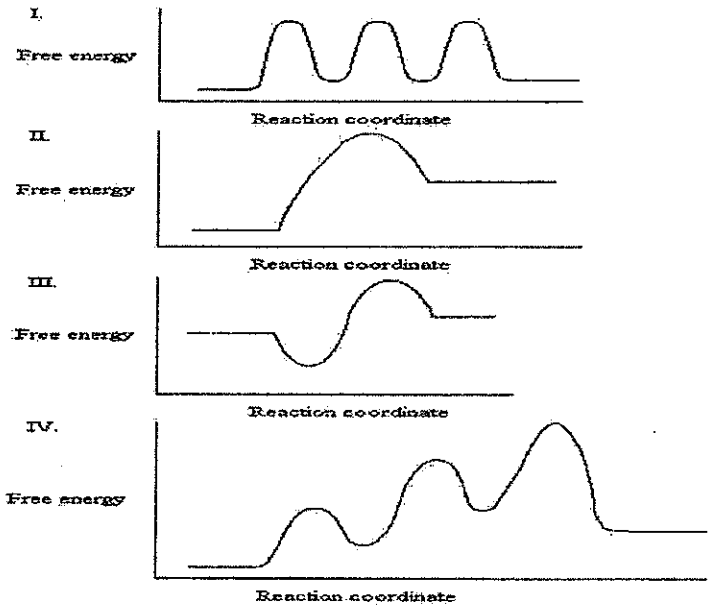
17. Superoxide dismutase enzyme catalysis is faster than the rate of diffusion because it

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.

18. An enzyme's active site contains an arginine residue and a glutamate residue with pKa's of 2.9 and 9.1, respectively. Both residues are actively involved in the catalytic mechanism and they are the only two ionizable residues in the active site. What would you expect for the optimum pH of the enzyme?

a). 3.0
b). 4.0
c). 6.0
d). 8.0
e). 9.0

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



a). See Graph I.
b). See Graph II.
c). See Graph III.
d). See Graph IV
e). See Graph I and IV.

20. Which of the following statements about the symmetry model of allosterism is <u>not</u> true?

a). the protein is an oligomer of symmetrically (or pseudosymmetrically) related subunits.
b). the oligomer can exist in two conformational states, which are in equilibrium.
c). the ligand can bind to a subunit in either conformation.
d). the molecular symmetry of the protein is conserved during the conformational change.
e). none of the above.

三、選擇題（70 分，每題 2 分）

21. Which of the following statements about the symmetry model of allosterism is <u>not</u> true?

a). the protein is an oligomer of symmetrically (or pseudosymmetrically) related subunits.
b). the oligomer can exist in two conformational states, which are in equilibrium.

c). the ligand can bind to a subunit in either conformation.
d). the molecular symmetry of the protein is conserved during the conformational change.
e). none of the above.

22. Antibodies recognize a huge variety of antigens because:

a). the cellular immune system has the potential to produce a large number of different antibodies
b). the diversity in antibody sequences arises instead from genetic changes during B lymphocyte development
c). 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

23. In hemoglobin, the transition from R state to T state (high to low oxygen binding affinity) is not triggered by:

a). the ion-pair between Asp94 and His-146 forms
b). pH in the blood is lower than 7.4
c). the pKa of His-146 is decreased
d). CO_2 binding
e). H+Hb.

Q24-25: In a laboratory experiment you completed a study of enzyme kinetics. The following data were collected:

Substrate concentration [S] (umolar)	50	120	300	500	800	1300	1800	2500
Velocity of Enzymatic reaction (umolar/min)	30	87	110	130	170	208	215	210

24. Estimate the Km for this substrate:enzyme combination without graphing the data.

a). 260
b). 860
c). 460
d). 1060
e). 1720

25. When add an inhibitor with fixed concentration to the enzymatic reaction of **[Q25]**, the velocity (umolar/min) of the reaction became: 46, 85, 99, 110, 120, 135, 148, 150. What is the function of this inhibitor?

a). Irreversible inhibition
b). Competitive inhibition
c). Noncompetitive inhibition
d). Uncompetitive inhibition
e). Non-classical inhibition

26. Cholesterol is a precursor to

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

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

27. 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

28. Which of these statements about the regulation of cholesterol synthesis is *not* true?

a). Cholesterol acquired in the diet has essentially no effect on the synthesis of cholesterol in the liver.
b). Failure to regulate cholesterol synthesis predisposes humans to atherosclerosis.

c). High intracellular cholesterol stimulates formation of cholesterol esters.
d). Insulin stimulates HMG-CoA reductase.
e). Some metabolite or derivative of cholesterol inhibits HMG-CoA reductase.

29. Fatty acids are activated to acyl-CoAs and the acyl group is further transferred to carnitine because:

a). acyl-carnitines may be transported cross the mitochondrial inner membrane, but acyl-CoAs do not.
b). acyl-CoAs easily cross the mitochondrial membrane, but the fatty acids themselves will not.
c). carnitine is required to oxidize NAD+ to NADH.
d). fatty acids cannot be oxidized by FAD unless they are in the acyl-carnitine form.
e). None of the above is true.

30. Which of the following accurately ranks lipoproteins from highest to lowest density?

a). chylomicrons > HDL > LDL > IDL > VLDL
b). HDL > IDL > LDL > VLDL > chylomicrons
c). HDL > LDL > IDL > VLDL > chylomicrons
d). chylomicrons > VLDL > IDL > LDL > HDL
e). VLDL > IDL > LDL > HDL > chylomicrons

31. An important structural lipid found in nerve cell membranes, _____, is a type of _____.

a). sphingomyelin, phospholipid
b). phosphatidylcholine, phospholipid
c). palmitate, glycerophospholipid
d). glucagon, hormone
e). none of the above

32. Which of the following is the starting metabolite in ketone body biosynthesis?

a). acetyl CoA
b). malonyl CoA
c). propionlyl CoA
d). acetyl CoA and propionyl CoA
e). acetyl CoA and malonyl CoA

33. In which location listed below does the following reaction take place?

HMG-CoA → acetoacetate + Acetyl-CoA

a). cytosol of cardiomyocytes
b). mitochondria of cardiomyocytes

c). cytosol of liver cells
d). mitochondria of liver cells
e). all of the above

34. 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

35. Unsaturated fatty acids:

a). are commonly found in plants and animals
b). usually contain a double bond with *cis* stereochemistry
c). sometimes contain multiple double bonds
d). have lower melting points than the analogous saturated fatty acids
e). all of the above

36. Triglycerides contain more metabolic energy per unit weight than glycogen because:

I. Glycogen has greater polarity than fatty acids.
II. Fatty acids predominate in an anhydrous form
III. Fatty acids are less oxidized than carbohydrates.
IV. Triglycerides have a higher average molecular mass.

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

37. Which of the following statements describes one reason that plant oils are generally healthier for human consumption than animal fats?

a). Plant oils usually contain more unsaturated fatty acids than animal fats.
b). Plant oils usually contain more *trans* fatty acids than animal fats.
c). Plant oils usually have a higher degree of saturation than animal fats.
d). Plant oils are glycerol based rather than phospholipid based.
e). Plant oils have shorter chain fatty acids than animal fats.

38. In eukaryotic cells the ATP-dependent degradation of ubiquitinated proteins is mediated by _____.

a). lysosomes
b). proteosomes
c). cathepsins
d). autophgasomes
e). endosomes

39. Infants who cannot properly degrade _____ develop jaundice.

a). bilirubin
b). folic acid
c). cholesterol
d). indole
e). phenylalanine

40. Ketogenic amino acids can be converted to_____

I. oxaloacetate
II. fatty acids
III. ketone bodies
IV. α–ketoglutarate

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

41. Oxidative deamination of glutamate

I. generates NAD(P)H and α-ketoglutarate.
II. is inhibited by glutamate.
III. is inhibited by GTP.
IV. eliminates the keto group from α-ketoacids.

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

42. Which of the following statements about maple syrup urine disease is/are true?

I. It is caused by a genetic deficiency in the enzyme branched-chain amino acid aminotransferase.
II. The disease is fatal unless promptly treated.
III. There is a buildup of the branched-chain α-keto acids.
IV. Patients with the disease excrete urine that smells like maple syrup.

a). I only
b). II only
c). I, III, IV
d). II, III, IV
e). All of the statements are true.

43. Several neurotransmitters are synthesized from amino acids via decarboxylation. These amino acid decarboxylases usually use _____ as a cofactor.

a). tetrahydrofolate
b). thiamine pyrophosphate
c). biotin
d). vitamin B_{12}
e). pyridoxal-5'-phosphate

44. Which of the following are essential amino acids for adult humans?

a). Arg, His, Gly, Try
b). Met, Gly, Thr, Try
c). His, Leu, Tyr, Ala
d). Met, Lys, His, Val
e). Ile, Arg, Cys, Ser

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

a). acetyl-CoA; ketogenic
b). succinyl-CoA; ketogenic
c). pyruvate; glucogenic
d). oxaloacetate; glucogenic
e). acetoacetate; ketogenic

46. Isocitrate dehydrogenase is found only in the mitochondria, but malate dehydrogenase is found in both the cytosol and mitochondria. What is the role of cytosolic malate dehydrogenase?

a). Cytosolic malate dehydrogenase plays a key role in the transport of reducing equivalents across the inner mitochondria membrane.
b). Cytosolic malate dehydrogenase is involved in generating of ATP by substrate-level phosphorylation.
c). Cytosolic malate dehydrogenase catalyzes the transformation of α-ketogularate to malate directly.
d). Cytosolic malate dehydrogenase is involved in NADPH production.
e). Only C and D.

47. Individuals with a disease caused by a specific defect in the mitochondrial genome may have symptoms ranging from mild to severe. Why?

a). The same mutation in different individuals may have different degree of penetrance.
b). The different genomic contents of different individuals cause the difference.
c). The DNA repair system in different individual may function different.
d). Different extents of heteroplasmy for the defective gene produce different degree of defective mitochondria function.
e). None of the above.

48. Although both pyruvate dehydrogenase and glyceraldehyde 3-phosphate dehydrogenase use NAD+ as their electron acceptor, the two enzymes do not compete the same cellular NAD+ pool. Why?

a). They are located in different cellular compartments.
b). The NAD^+ pools are separated by the inner membrane of mitochondria.
c). NAD^+ can not freely transfer across the inner membrane of mitochondria
d). Pyruvate dehydrogenase is located in cytosol and glyceraldehyde 3-phosphate dehydrogenase is in mitochondria.
e). A, B, and C

49. During oxidative phosphorylation, the proton motive force that is generated by electron transport is used to:

a). create a pore in the inner mitochondrial membrane
b). generate the substrates (ADP and P_i) for the ATP synthase.
c). induce a conformational change in the ATP synthase.
d). oxidize NADH to NAD^+.
e). reduce O_2 to H_2O.

50. A new compound isolated from mitochondria is claimed to represent a previously unrecognized carrier in the electron transfer chain. It is given the name coenzyme Z. Which line of evidence do you feel is the "least" conclusive in assigning this compound a position in the electron transfer chain?

a). Alternate oxidation and reduction of the mitochondrion-bound coenzyme Z can be readily demonstrated.
b). Removal of coenzyme Z from the mitochondria results in a decreased rate of oxygen consumption.
c). The rate of oxidation and reduction of mitochondrion-bound coenzyme Z is of the same order of magnitude as the overall rate of electron transfer in mitochondria as measured by oxygen consumption.
d). The reduction potential of Z is between that of two compounds known to participate in the electron transport chain.
e). When added to a mitochondrial suspension, coenzyme Z is taken up very rapidly and specifically by the mitochondria.

51. Retenone, a toxic natural product from plants, strongly inhibits NADH dehydrogenase of insect and fish mitochondria. Which statement about the mode of action of retenone is incorrect?

a). It can inhibit the electron transfer by targeting Complex IV.
b). It decreases the electron flow of the respiratory chain.
c). It decreases the rate of ATP production.
d). It prevents electron transfer form Fe-S center to ubiquinone.
e). The effect is similar to the compound Amytal.

52. Single nucleotide changes in the gene for succinate dehydrogenase (Complex) are associated with midgut carcinoid tumors. What might be a possible mechanism to explain this observation?

a). Defects in Complex II result in increased ROS, damage to DNA and mutations that eventually lead to tumor transformation.
b). Defects in Complex II result in decreased ATP that leads to tumor formation.
c). Succinate dehydrogenase also functions as a tumor suppressor, mutations in Complex II lead to tumor formation.
d). Single nucleotide polymorphism in the succinate dehydrogenase gene leads to the increase of the efficiency of ETC, therefore, induces the formation of midgut carcinoid tumors.
e). None of the above.

53. In electron transfer, only the quinone portion of ubiquinone undergoes oxidation-reduction. What is the biological function of the isoprenoid side chain of the ubiquinone?

a). It is involved directly in electron transfer.

b). It stabilizes the electron in ubiquinone by resonance.
c). It makes ubiquinone lipophilic and allows it to diffuse in the mitochondrial inner membrane.
d). It transfers electrons as a hydride ion.
e). It associates with inorganic sulfur atoms or with the sulfur atoms of Cys residues in the membrane proteins.

54. Which one of the following enzymatic activities would be decreased by thiamine deficiency?

a). Fumarase
b). Isocitrate dehydrogenase
c). Malate dehydrogenase
d). Succinate dehydrogenase
e). α-Ketoglutarate dehydrogenase complex

55. There is reciprocal regulation of glycolytic and gluconeogenic reactions interconverting fructose-6-phosphate and fructose-1,6-bisphosphate. Which one of the following statements about this regulation is not correct?

a). Fructose-2,6-bisphosphate activates phosphofructokinase-1
b). Fructose-2,6-bisphosphate inhibits fructose-1,6-bisphosphatase.
c). The fructose-1,6-bisphosphatase reaction is exergonic
d). The phosphofructokinase-1 reaction is endergonic
e). This regulation allows control of the direction of net metabolite flow through the pathway

四、問答題（10 分）

56. Please describe the pathways about de novo biosynthesis, catabolism and nucleotide salvage of purine metabolism and their clinical correlations. (10%)