國立成功大學 106 學年度碩士班招生考試試題

系　　所：生物化學暨分子生物學研究所、臨床藥學與藥物科技研究所

考試科目：生物化學　　考試日期：0214，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、選擇題（25 分，每題 1 分）

1. Which of the following is true?
   A. Oxidation of the Fe(III) of myoglobin or hemoglobin is responsible for the brown color of old meat and dried blood
   B. The protein portion of myoglobin (and hemoglobin) prevents oxidation of the Fe(II)–heme complex
   C. Oxidation alters the electronic state of the Fe(II)–heme complex
   D. Ferric but not Ferrous binds O_2
   E. The strong competition of CO with oxygen for heme binding within capillaries accounts for a better tissue oxygen-consumption

2. 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. The lines in Hill plot for the normal hemoglobin is linear, and for hypothetical hemoglobin is non-linear.
   B. The two hemoglobins would be able to deliver about the same amount of oxygen to the tissues.
   C. There is a cooperative interaction between oxygen-binding sites in both the hypothetical and normal hemoglobins.
   D. The hypothetical hemoglobin has a greater oxygen affinity than normal hemoglobin.
   E. At pO_2 less than p_{50}, normal hemoglobin has a significantly lower fractional saturation (Y_{O_2}) value.

3. Carbon monoxide poisoning occurs when
   A. Myoglobin structure enhances the binding of CO to heme, compared to the myoblobin-free heme
   B. The carbon monoxide-bound heme is removed from myoglobin
   C. Ferrous binds to carbon monoxide
   D. Carbon monoxide binds to Fe(II) within myoglobin and hemoglobin
   E. The bindings of O_2 to Fe(III) is over-competed with CO

4. _____, the variant responsible for the misshapen red blood cells characteristic of the disease sickle-cell anemia, is potentially advantageous to heterozygotes because it confers some level of resistance to the disease malaria.
   A. Hemoglobin α
   B. Hemoglobin β
   C. Hemoglobin S
   D. Hemoglobin γ
   E. Myoglobin

5. Why does the dried blood exhibit brown color?

A. Oxidization of Ferrous–heme complex within myoglobin or hemoglobin
B. Oxygenation of Ferrous–heme complex within myoglobin or hemoglobin
C. Oxidization of Ferric–heme complex within myoglobin or hemoglobin
D. Oxygenation of Ferric–heme complex within myoglobin or hemoglobin
E. Complex formation between ferrous and heme

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

A. Decreased BPG binding biases the adult 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

7. The rearrangement of T state hemoglobin to the R state

A. involves the movement of the Fe(II) into the heme plane.
B. opens a central cavity for BPG binding.
C. increases the ion pairing interactions of the *C*-terminal amino acids.
D. occurs in each protein subunit independently when its heme binds oxygen.
E. requires the binding of at least three oxygen molecules.

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

A. During muscle relaxation the sarcomere becomes shorter.
B. During muscle contraction the I band becomes shorter.
C. During muscle contraction the H zone becomes longer.
D. During muscle relaxation the distance between the Z disk and the M disk becomes shorter.
E. During muscle relaxation calcium is released from ER to bind to TnC.

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

A. Thick filament moves the thin filament.
B. Titin measures the distance between M disk and Z disk during muscle relaxation.
C. Minus ends of thin filaments are associated to the Z disk.
D. Nebulin measures the length of thin filament.
E. Tropomodulin binds to Minus ends of thin filaments to prevent the actin depolymerization.

10. Which statement about actin is true?

A. There is only one actin gene responsible for F-actin and G-actin through alternative splicing.
B. Monomeric F-actin polymerizes to form G-actin.
C. Actin filaments are polar.
D. Actin can bind GTP.
E. Actin is an uncommon protein in nonmuscle cells.

11. Which of the following antibody-mediated autoimmune diseases targets the thyroid gland:

A. Addison's disease
B. Myasthenia gravis
C. Rheumatoid arthritis
D. Systemic lupus erythematosus
E. Graves' disease

12. 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–bone marrow barrier
D. antibodies against certain pathogens that cross-react with self antigens
E. generalized breakdown of the immune system, so that antibodies are inefficient to many endogenous substances

13. Antibodies recognize a huge variety of antigens because:

A. the humoral immune system has the potential to produce a large number of different antibodies
B. the diversity in antibody sequences arises 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

14. Which mode(s) of catalysis is/are classified as chemical effects?

1. Carbocation reactions
2. Acid-base catalysis
3. Nucleophilic subtraction reactions
4. Dehydrogenation reactions
5. Diffusion-controlled reactions

A. 1 and 2.
B. 1, 2, and 3.
C. 1, 2, and 4.
D. 2 and 4.
E. All of the above.

15. In the reaction below, Y^- is _____.

$$Y^- + CH_2X \rightarrow CH_2Y + X^-$$

1. the reaction intermediate
2. attacking the electrophile
3. attacking the nucleophile
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

16. Cleavage of a C-C bond produces a carbanion that _____ both electrons and a carbocation that _____ both electrons.

A. loses; loses
B. loses; keeps
C. keeps; loses
D. keeps; keeps
E. loses; shares

17. Which of the following statements is FALSE?

A. Enzymes make reactions 10^3 to 10^{20} times faster.
B. Enzymes lower the amount of energy needed for a reaction.
C. Enzymes are chemically unchanged during the actual catalytic process.
D. Enzymes speed up the attainment of a reaction equilibrium.
E. Enzymes are usually proteins.

18. In the following chemical reaction which species is the reducing agent?

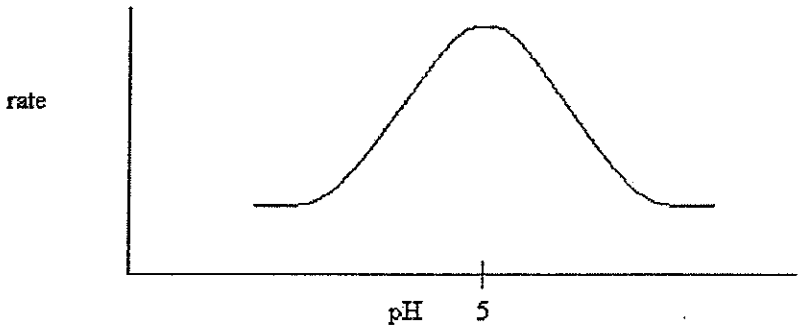
$$CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$$

A. CH4
B. O_2
C. CO_2
D. H_2O
E. None of the above, this is not an oxidation-reduction reaction.

19. Which statement does not apply to transition states?

A. Differ in energy from the ground state by the activation energy.
B. Chemical bonds are in the process of being formed and broken.
C. Have lifetimes on the order of 10^{-14} to 10^{-13} seconds.
D. Many have been detected experimentally.
E. All of the above.

20. 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 and 3
B. 1 and 4
C. 1, 3, and 4
D. 2 only
E. 5 only

21. 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?

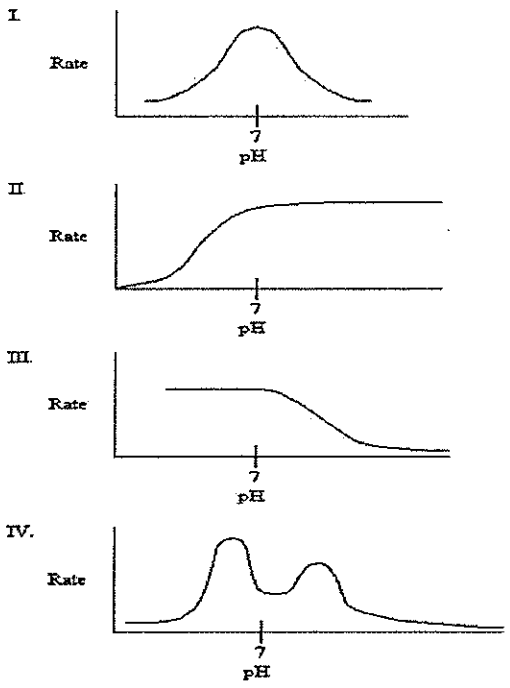
1. Aspartate is protonated; lysine is deprotonated.
2. Both residues are ionized.
3. Aspartate is deprotonated; lysine is protonated.
4. Both residues are deprotonated.

A. 1 only
B. 2 only
C. 1 and 2
D. 2 and 3
E. 4 only

22. The active site of a certain enzyme contains a serine residue. When the enzyme is incubated for a short time with its substrate, a form of the enzyme in which the active site serine is acetylated can be isolated and purified. In the native protein the serine is never found to be acetylated. This information supports _____.

A. the acid-base catalysis mode
B. intermediate state stabilization effects
C. a covalent catalysis mode
D. a polar group catalytic mechanism
E. an induced fit mode

23. 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?

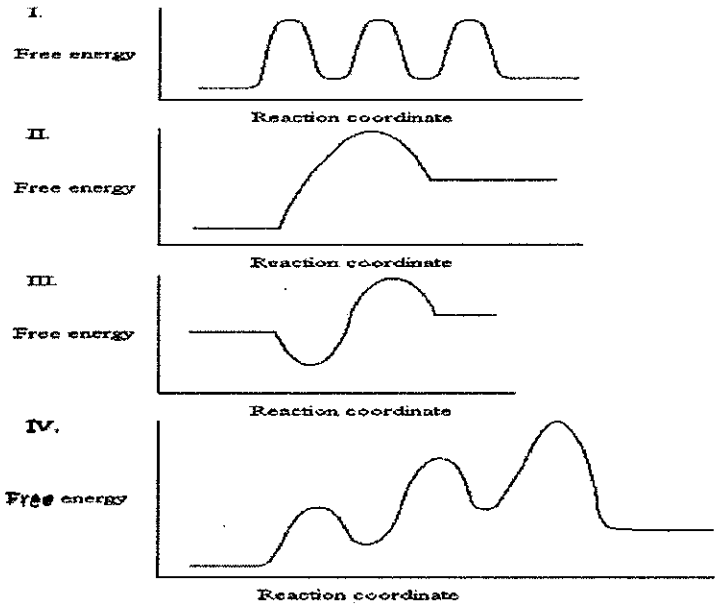


A. I
B. II
C. III
D. IV
E. II and III

24. 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.

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



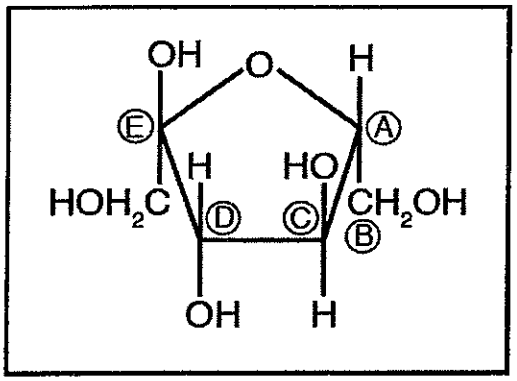
A. See Graph I.
B. See Graph II.
C. See Graph III.
D. See Graph IV
E. See Graph I and IV.

二、選擇題（62 分，每題 2 分）

26. Which of these polysaccharides is a branched polymer?

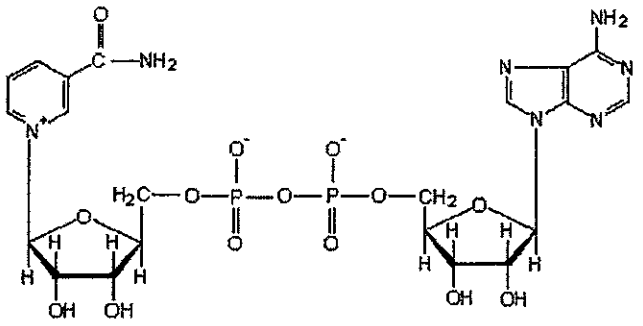
A. chitin
B. amylose
C. cellulose
D. amylopectin
E. hyaluronic acid

27. The configuration around which carbon atom shown in the figure above determines whether this is a D or an L sugar?



A. A
B. B
C. C
D. D
E. E

28. Identify the structure pictured below.



A. NAD^+
B. NADH
C. FAD
D. $FADH_2$
E. Coenzyme A (CoA)

29. Consider the following metabolic reaction:

Succinyl-CoA + Acetoacetate ⟶ Acetoacetyl-CoA + Succinate　$G^{o\prime} = -1.25$ kJ/mol

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

30. The vitamin _____ is one of the components of coenzyme A, which is involved in _____.

A. pantothenic acid; carboxylation
B. pantothenic acid; acyl transfer
C. cobalamin; acyl transfer
D. riboflavin; carboxylation
E. niacin; electron transfer

31. Which is the net equation for aerobic glycolysis?

A. Glucose + 2 ATP → 2 lactate + 2 ADP + 2 P_i
B. Glucose + 2 ADP + 2 P_i + 2 NAD^+ → 2 pyruvate + 2 ATP + 2 NADH + 2 H_2O + $4H^+$
C. Glucose + 2 ADP + 2 P_i → 2 lactate + 4 ATP + 4 H^+
D. Glucose + 2 ATP + 2 NAD^+ → 2 pyruvate + 4 ATP + 4 NADH + 4 H^+
E. Glucose + 2 ADP + 2 P_i + 2 NAD^+ → 2 lactate + 4 ATP + 2 NADH + 4 H^+

32. Phosphofructokinase is allosterically _____ by high concentrations of _____.

I. activated; ATP
II. inhibited; ATP
III. inhibited; fructose-2,6-bisphosphate
IV. activated; fructose -2,6-bisphosphate

A. I, III
B. II, III
C. II, IV
D. I, IV
E. none of the above

33. Which of the following is correct regarding the hexose monophosphate shunt?

I. NADH is generated by the oxidation of glucose-6-phosphate.
II. Glyceraldehyde-3-phosphate is generated in the reaction.
III. The pathway requires a transaldolase.
IV. The pathway generates 3 ATP per 1 glucose-6-phosphate.

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

34. Which of the following aides in formation of a primer for glycogen synthesis?

A. glycogen synthase
B. UDP-glucose pyrophosphatate
C. glycogenin
D. UDP–glycogen
E. amylo-(1,4→1,6)-transglycosylase

35. 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

36. Which of the following statements about glycogen is true?

I. Glycogen is a polymer of glucose in α(1→6) linkages with α(1→4) linked branches every 8–14 residues.
II. UDP–glucose is produced from glycogen by the action of the enzyme phosphorylase.
III. In glycogen breakdown, glucose residues are sequentially removed from the nonreducing ends.
IV. The breakdown of glycogen in skeletal muscle ultimately supplies glucose-6-phosphate, which can enter glycolysis to generate ATP.

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

37. One turn of the citric acid cycle generates

A. 2 $FADH_2$, 3 ATP, 1 NADH
B. 1 NAD+, 2$FADH_2$, 1 ATP
C. 1 GTP, 3 NADH, 1 $FADH_2$
D. 1 FAD, 2 ATP, 3 NADH
E. 1 $FADH_2$, 1GTP, 2 NADH

38. Which of the following utilizes intermediates of the citric acid cycle?

I. gluconeogenesis
II. amino acid biosynthesis
III. fatty acid oxidation
IV. glycolysis

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

39. Glutamate is metabolically converted to α-ketoglutarate and NH_4^+ by a process in the liver cells described as:

A. transamination
B. transketolation
C. oxidative transamination
D. oxidative deamination
E. hydrolysis

40. The amino acids serine, alanine, and cysteine can be directly converted to:

A. oxaloacetate
B. fumarate
C. pyruvate
D. succinyl-CoA
E. α-ketoglutarate

41. Which of the following conversions require vitamin B_{12} as a coenzyme in mammalian?

I. homocysteine → methionine
II. phenylalanine → hydroxyphenylpyruvate
III. glutamate → α–ketoglutarate
IV. methylmalonyl-CoA → succinyl- CoA
V. proline → glutamate

A. I and II
B. I and IV
C. II and III
D. III and IV
E. IV and V

42. In maple syrup urine disease the metabolic defect involves:

A. a deficiency of the vitamin B_6.
B. oxidative decarboxylation.
C. synthesis of branched chain amino acids.
D. transamination of a group of amino acids.
E. oxidation of tyrosine.

43. Which of the following statements of ubiquitin are **incorrect**?

I. Ubiquitinated proteins are proteolytically degraded in an ATP-independent process.
II. The ubiquitin protein is a 76-residue monomeric protein that is highly abundant in eukaryotic cells.
III. In protein ubiquitination reaction the ubiquitin's terminal carboxyl group is transferred to the Lys ε-amino group on the target protein to form an isopeptide bond.
IV. The polyubiquitinated proteins are proteolytically degraded in lysosomes.

A. I and II
B. II and III
C. III and IV
D. I and IV
E. II and IV

44. Which of the following statements of nitric oxide NO are **incorrect**?

I. NO is synthesized by endothelial cells and causes the underlying smooth muscle to contract.
II. NO is derived from lysine.
III. NO is one of the decomposition products of nitroglycerin that is often administrated to the patients suffering angina pectoris to release their chest pain.
IV. The reaction that converted a specific amino acid to NO is catalyzed by nitric oxide synthase.

A. I and II
B. II and III
C. III and IV
D. I and III
E. II and IV

45. Which of the following statements of heme are **incorrect**?

I. Heme is synthesized from histidine and glycine.
II. δ-aminolevulinic acid is an intermediate in heme biosynthesis.
III. Genetic defects in heme biosynthesis will result in jaundice.
IV. Bilirubin is one of the major degradation products of heme found in the bile.

A. I and II
B. II and III
C. III and IV
D. I and III
E. II and IV

46. The human genetic disease albinism can result from defect in:

A. conversion of tyrosine to melanin.
B. catabolism of ketone bodies.
C. conversion of phenylalanine to tyrosine.
D. biosynthesis of phenylalanine.
E. conversion of tryptophan to serotonin.

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

A. acyl-carnitines readily 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.

48. What is the correct order of function of the following enzymes of β oxidation?

1. β-Hydroxyacyl-CoA dehydrogenase
2. Thiolase
3. Enoyl-CoA hydratase
4. Acyl-CoA dehydrogenase

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

49. The following fatty acid, in which the indicated carbon is labeled with ^{14}C, is fed to an animal:

$$^{14}CH_3(CH_2)_9COOH$$

After allowing 30 minutes for fatty acid β oxidation, the label would most likely be recovered in:

A. acetyl-CoA.
B. beta-hydroxy butyryl-CoA.
C. both acetyl-CoA and propionyl-CoA.
D. palmitoyl-CoA.
E. propionyl-CoA.

50. When comparing the β-oxidation and ω-oxidation pathways, which one of the following statements is correct?

A. β-oxidation and ω-oxidation occur in the cytoplasm.
B. β oxidation occurs at the carboxyl end of the fatty acid whereas ω oxidation occurs at the methyl end.
C. β oxidation occurs at the methyl end of the fatty acid whereas ω oxidation occurs at the carboxyl end.
D. β oxidation occurs mainly in the cytoplasm whereas ω oxidation occurs mainly in the mitochondria.
E. β oxidation occurs mainly in the mitochondria whereas ω oxidation occurs mainly in the cytoplasm.

51. Ketone bodies are formed in the liver and transported to the extrahepatic tissues mainly as:

A. acetoacetyl-CoA.
B. acetone.
C. beta-hydroxybutyric acid.
D. beta-hydroxybutyryl-CoA.
E. lactic acid.

52. If malonyl-CoA is synthesized from $^{14}CO_2$ and unlabeled acetyl-CoA, and the labeled malonate is then used for fatty acid synthesis, the final product (fatty acid) will have radioactive carbon in:

A. every C.
B. every even-numbered C-atom.
C. every odd-numbered C-atom.
D. no part of the molecule.
E. only the omega-carbon atom (farthest carbon from C-1).

53. The enzyme system for adding double bonds to saturated fatty acids requires all of the following *except:*

A. a mixed-function oxidase.
B. ATP.
C. cytochrome b_5.
D. molecular oxygen (O_2).
E. NADPH.

54. Which of these statements about cholesterol synthesis is true?

A. Cholesterol is the only known natural product whose biosynthesis involves isoprene units.
B. Only half of the carbon atoms of cholesterol are derived from acetate.
C. Squalene synthesis from farnesyl pyrophosphate results in the release of two moles of PP_i for each mole of squalene formed.
D. The activated intermediates in the pathway are CDP-derivatives.
E. The condensation of two five-carbon units to yield geranyl pyrophosphate occurs in a "head-to-head" fashion.

55. 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.

56. Palmitoyl-CoA is a direct precursor of:

A. cholesterol.
B. malonyl-CoA.
C. mevalonate
D. sphingosine.
E. squalene.

三、填充題與問答題 （13 分）

57. The synthesis of fatty acids and their breakdown by β oxidation occur by separate pathways. Compare the two paths by filling in the blanks below. (Some blanks may require more than one answer.) (1 point each)

	Synthesis	β oxidation
Activating group	(1)	CoA—SH
Electron carrier coenzyme(s)	NADPH	(2)
Basic units added or removed	(3)	acetyl-
Cellular location of process	(4)	(5)

58. Please describe the pathogenesis of severe combined immunodeficiency related purine metabolism and their possible therapeutic strategy. (4%)

59. Please describe the possible biochemical causes of gout and its treatments. (4%)