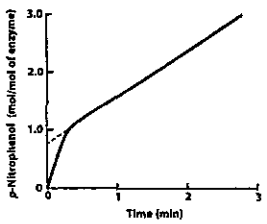
※ 請使用 2B 鉛筆於答案卡上作答

單選題，每題 2 分。

1. In 1954 Hartley and Kirby reported the pre-steady state kinetic evidence (so-called "rapid burst") of chymotrypsin hydrolysis of the ester p-nitrophylacetate to prove the existence of an acyl-enzyme intermediate, as shown in the attached figure. Please find out which of the following is FALSE.
(A) The burst phase corresponded to just under one molecule of p-nitrophenol released for every enzyme molecule present.
(B) The formation of acyl-enzyme intermediate is slower than that of the deacylation step.
(C) The formation of acyl-enzyme intermediate is the rate-limiting step
(D) When using p-nitrophenylacetamide (the amide analogue) as the substrate, there is no observation of rapid burst.
(E) The study was observed to give a color change (turning to yellow)..



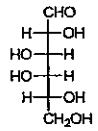
Questions 2-4: Regarding to the reaction mechanism of chymotrypsin-catalyzed hydrolysis, please answer the questions 2-4 by selecting the following amino acid residues (A) His 57 (B) Ser 195 (C) Gly 193 (D) Cys 122 (E) Asp 102

2. Which residue functions as a general acid to protonate the amino leaving group?

3. The mechanism contains two stages, including acylation and deacylation. The nucleophile in the acylation phase is a hydroxyl group. The pKa is generally too high for the deprotonated form to be present in significant concentrations at physiological pH. Please identify which residue, working together with His 57, functions to lower the pKa in order to enhance the nucleophilicity?

4. After the hydroxyl group attacks the carbonyl group of the substrate, a very short-lived tetrahedral intermediate forms. At this stage, the original carbonyl oxygen acquires a negative charge. Which residue and Gly 193 provide their backbone amides to stabilize the resulting negative charge by hydrogen bonding interactions?

5. The structure of D-galactose is shown below. How many cyclic isomers of D-galactose can form in aqueous solution? (A) 1 (B) 2 (C) 3 (D) 4 (E) 5



6. How many isomeric disaccharides can be formed if **D-galactopyranose** is used as the monomeric unit? (A) 24 (B) 30 (C) 36 (D) 25 (E) 60

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7. There are a number of inherited human diseases related to the abnormal metabolism of membrane lipids, such as Sandhoff's disease, Tay-Sachs disease, and Fabry's disease. Please identify which one of the following statements is NOT correct.
(A) These diseases are caused by genetic defect(s) in any of these hydrolytic enzymes
(B) The involved enzymes are located in the lysosomes
(C) The accumulated membrane lipids are often glycolipids
(D) The diseases have severe medical consequences, such as mental retardation and early death.
(E) The genetic defect(s) cause malfunction of glyco-related synthetic enzymes

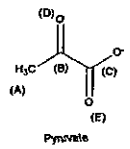
8. In the citric acid cycle there are eight reaction steps. Which enzyme catalyzes the release of carbon dioxide? (A) Malate dehydrogenase (B) Citrate synthase (C) Aconitase (D) Isocitrate dehydrogenase (E) Succinyl-CoA synthetase

9. Continued from the last question, which enzyme is located at the inner mitochondrial membrane, unlike the other enzymes residing in the mitochondrial matrix?
(A) Aconitase (B) Isocitrate dehydrogenase (C) α-ketoglutarate dehydrogenase
(D) Succinyl-CoA synthetase (E) Succinate dehydrogenase

10. Cofactors usually play an important role in enzyme catalysis. Which enzyme requires lipoic acid as a coenzyme?
(A) Isocitrate dehydrogenase (B) α-ketoglutarate dehydrogenase (C) Succinyl-CoA synthetase
(D) Succinate dehydrogenase (E) Aconitase

11. Thiamine pyrophosphate (TPP) is one of the key enzyme cofactors involved in alcohol fermentation. Which of the following statement clearly explain the cofactor's functional role?
(A) TPP helps the enzyme to proceed decarboxylation
(B) TPP functions like NAD^+ to be involved in reduction/oxidation
(C) TPP functions like FAD to be involved in electron transfer
(D) TPP helps the enzyme to proceed dehydrogenation (to form a double bond)
(E) TPP helps the enzyme to proceed oxidation from $-CH_2OH$ to $-CHO$

12. Thiamine pyrophosphate (TPP) also involves in the formation of acetyl CoA, in which TPP has to be deprotonated first and then attacks one site of pyruvate. Please identify which site.



Pyruvate

13. Which compound is involved in the cause of tooth decay?
(A) phospho(enol)pyruvate (B) glutaric acid (C) glucose (D) lactic acid (E) glucuronic acid

14. In addition to producing five-carbon sugars, which is also the other important function of the pentose phosphate pathway?
(A) to generate NADH (B) to generate $FADH_2$ (C) to generate NADPH (D) to generate NAD^+
(E) to generate $NADP^+$

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15. With respect to the glyoxylate cycle, which of the following enzymes catalyzes the formation of glyoxylate?
(A) Isocitrate dehydrogenase (B) α-ketoglutarate dehydrogenase (C)Isocitrate lyase
(D) Malate synthase (E)Citrate synthase

16. Which one of the following reactions is called an anaplerotic reaction (hint: the term "anaplerotic" means "filling up" or "to replenish")?
(A) the reaction from malate to oxaloacetate
(B) the reaction from pyruvate to oxaloacetate
(C) the reaction from oxaloacetate and acetyl CoA to citrate
(D) the reaction from pyruvate to acetyl CoA

17. Pregnant women are not advised to take alcohol because of the consideration of fetal alcohol syndrome. The toxic compound is generated by the mother, transferred across the placenta, and then accumulated in the liver of the fetus. What is the toxic compound?
(A) Ethanol (B) Formaldehyde (C) Lactate (D) Acetaldehyde (E) Methanol

18. NADH is an important coenzyme in catabolic process, whereas NADPH appears in anabolic processes. There are two reactions that are responsible for the exchange of NADH and NADPH. Which one of the following molecules is NOT involved in the two reactions?
(A) Malate (B) Oxaloacetate (C) Pyruvate (D) Fumarate (E) carbon dioxide

19. Which of the following disaccharides could be extended to form a starch polymer?
(A) Sucrose (B) Trehalose (C) Maltose (D) Lactose (E) Isomaltose

20. Which of the following is a heteropolysaccharide?
(A) Glycogen (B) Hyaluronate (C) Starch (D) Cellulose (E) Chitin

21. In order to examine the citric acid cycle, you have obtained a pure preparation of isolated, intact mitochondria. You add some succinyl-CoA to the suspension of mitochondria. How many molecules of ATP would you expect to be generated in one turn of the citric acid cycle from each mole of succinyl-CoA added to the test tube?
(A) 4 (B) 5 (C) 6 (D) 7. (E) No ATP would form under these conditions

22. Carbon fixation involves a condensation reaction between CO_2 and
(A) 3-phosphoglycerate (B) Phosphoglycorate (C) ribulose-1,5-bisphosphate
(D) fructose-6-phosphate (E) ribose-5-phosphate

23. Given that plants can produce ATP and NADPH from photophosphorylation, for what purpose(s) do they reduce CO_2 to glucose?
(A) At night, plant need ATP produced by glycolysis and the citric acid cycle in the dark.
(B) Plants need glucose to produce starch and cellulose
(C) Plants need glucose as a precursor of components of nucleic acids, lipids and proteins.
(D) Both options of (B) and (C)
(E) All the options of (A), (B) and (C)

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24. Regarding to a competitive inhibitor, which parameter of the following increases its value?
(A) k_{cat}
(B) K_M
(C) k_{cat}/K_M
(D) None of the options of (A), (B) and (C)
(E) All the options of (A), (B) and (C)

25. Ribulose-1,5-bisphosphate carboxylase/oxygenase is arguably the most important enzyme on earth because nearly all life is dependent, ultimately, on its action. The reactions catalyzed by this enzyme are influenced by
(A) pH (B) substrate concentration (C) Mg^{2+} concentration (D) temperature (E) All of the above

26. In amino acid catabolism, the first reaction for many amino acids is a(n):
(A) oxidative deamination requiring NAD^+.
(B) hydroxylation requiring NADPH and O_2.
(C) transamination requiring pyridoxal phosphate (PLP).
(D) reduction requiring pyridoxal phosphate (PLP).
(E) decarboxylation requiring thiamine pyrophosphate (TPP).

27. Which of the following is ***not true*** of the reaction catalyzed by glutamate dehydrogenase?
(A) NH_4^+ is produced.
(B) It is similar to transamination in that it involves the coenzyme pyridoxal phosphate (PLP).
(C) The enzyme is glutamate-specific.
(D) The enzyme can use either NAD^+ or $NADP^+$ as a cofactor.
(E) α-Ketoglutarate is produced from an amino acid.

28. Which of these ***directly*** donates a nitrogen atom for the formation of urea during the urea cycle?
(A) adenine (B) glutamate (C) ornithine (D) aspartate (E) creatine

29. Glutamate is metabolically converted to α-ketoglutarate and NH_4^+ by a process described as:
(A) reductive deamination. (B) hydrolysis. (C) transamination. (D) deamination. (E) oxidative deamination.

30. Which one of the following amino acids is critical for glutathione to function as a redox buffer in cells?
(A) glycine. (B) cysteine. (C) glutamine. (D) glutamate. (E) methionine.

31. If a cell were unable to synthesize or obtain tetrahydrofolic acid (H_4 folate), it would probably be deficient in the biosynthesis of:
(A) isoleucine. (B) leucine. (C) lysine. (D) methionine. (E) serine.

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32. Which of the following statements about urea cycle is ***false***?
(A) The pathways of the citric acid cycle and the urea cycle are interconnected.
(B) The urea cycle causes a net conversion of oxaloacetate to malate.
(C) The regeneration of oxaloacetate from fumarate produces NADH in the malate dehydrogenase reaction.
(D) The pathway interconnections reduce the energetic cost of urea synthesis.
(E) The pathway interconnection is called aspartate-argininosuccinate shunt of citric acid cycle.

33. Nonessential amino acids:
(A) are synthesized by plants and bacteria, but not by humans.
(B) are amino acids other than those required for protein synthesis.
(C) are not utilized in mammalian proteins.
(D) can be synthesized in humans as well as in bacteria.
(E) may be substituted with other amino acids in proteins.

34. Which one of the following statements is ***true***?
(A) Muscle cannot use fatty acids as an energy source.
(B) The brain prefers glucose as an energy source, but can use ketone bodies.
(C) Amino acids are a preferable energy source over fatty acids in mammals.
(D) Fatty acids cannot be used as an energy source in humans because humans lack the enzymes of the glyoxylate cycle.
(E) In a well-fed human, about equal amounts of energy are stored as glycogen and as triacylglycerol.

35. One amino acid ***directly*** involved in the purine biosynthetic pathway is:
(A) leucine. (B) tryptophan (C) glutamate. (D) alanine. (E) aspartate.

36. Which one of the following enzymes is involved in the salvage pathways for the formation of nucleotides?
(A) hypoxanthine-guanine phosphoribosyltransferase.
(B) xanthine oxidase.
(C) nucleoside monophosphate kinases.
(D) glutamine amidotransferases.
(E) ribose phosphate pyrophosphokinase.

37. A cell that is unable to synthesize or obtain tetrahydrofolic acid (H_4 folate) would probably be deficient in the biosynthesis of:
(A) UMP. (B) dTMP. (C) orotate. (D) GMP. (E) CMP.

38. The ribosyl phosphate moiety needed for the synthesis of orotidylate, inosinate, and guanylate is provided most directly by:
(A) 5-phosphoribosyl 1-pyrophosphate. (B) adenosine 5′-phosphate. (C) guanosine 5′-phosphate.
(D) ribose 5-phosphate. (E) ribulose 5-phosphate.

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39. Which of the following is ***not true*** of the reaction catalyzed by ribonucleotide reductase?
(A) Glutathione can be part of the path of electron transfer.
(B) It acts on nucleoside diphosphates.
(C) Its mechanism involves formation of a free radical.
(D) There is a separate enzyme for each nucleotide (ADP, CDP, GDP, UDP).
(E) Thioredoxin is one of the essential electron carriers.

40. dTMP is synthesized from dUMP through a reaction of:
(A) deamination. (B) methylation. (C) decaroxylation. (D) amination. (E) hydroxylation.

41. The difference between a ribonucleotide and a deoxyribonucleotide is:
(A) a deoxyribonucleotide has an —H instead of an —OH at C-2.
(B) a deoxyribonucleotide has α configuration; ribonucleotide has the β configuration at C-1.
(C) a ribonucleotide has an extra —OH at C-4.
(D) a ribonucleotide has more structural flexibility than deoxyribonucleotide.
(E) a ribonucleotide is a pyranose, deoxyribonucleotide is a furanose.

42. When double-stranded DNA is heated at neutral pH, which change does ***not*** occur?
(A) The absorption of ultraviolet (260 nm) light increases.
(B) The covalent *N*-glycosidic bond between the base and the pentose breaks.
(C) The helical structure unwinds.
(D) The hydrogen bonds between A and T break.
(E) The viscosity of the solution decreases.

43. In double-stranded DNA:
(A) only a right-handed helix is possible.
(B) sequences rich in A–T base pairs are denatured less readily than those rich in G–C pairs.
(C) the sequence of bases has no effect on the overall structure.
(D) the two strands are parallel.
(E) the two strands have complementary sequences.

44. The double helix of DNA in the B-form is stabilized **mostly** by:
(A) hydrogen bonds between the riboses of each strand.
(B) ribose interactions with the planar base pairs.
(C) nonspecific base-stacking interaction between two adjacent bases in the same strand.
(D) hydrogen bonding between the phosphate groups of two side-by-side strands.
(E) covalent bonds between the 3′ end of one strand and the 5′ end of the other.

45. The nucleic acid bases:
(A) are roughly planar.
(B) are all about the same size.
(C) can all stably base-pair with one another.
(D) absorb ultraviolet light maximally at 280 nm.
(E) are relatively hydrophilic.

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46. DNA in a closed-circular, double-stranded molecule with no net bending of the DNA axis on itself is:
(A) a left-handed helix.
(B) a mixed right- and left-handed helix.
(C) underwound.
(D) supercoiled.
(E) relaxed.

47. A condensed eukaryotic chromosome is known to be associated with all of the following proteins, *except* for:
(A) Core histones H2A, H2B, H3, and H4.
(B) Histone H1.
(C) Topoisomerase I.
(D) Topoisomerase II.
(E) SMC proteins.

48. The Meselson-Stahl experiment established that:
(A) DNA polymerase has a crucial role in DNA synthesis.
(B) DNA synthesis in *E. coli* proceeds by a conservative mechanism.
(C)DNA synthesis in *E. coli* proceeds by a semiconservative mechanism.
(D) DNA synthesis requires dATP, dCTP, dGTP, and dTTP.
(E) newly synthesized DNA in *E. coli* has a different base composition than the preexisting DNA.

49. Which of the following is *not* known to be involved in initiation by eukaryotic RNA polymerase II?
(A) DNA helicase activity
(B) DNA polymerase activity
(C)Formation of an open complex
(D) Protein binding to specific DNA sequences
(E) Protein phosphorylation

50. The enzyme that attaches an amino acid to a tRNA (aminoacyl-tRNA synthetase):
(A) always recognizes only one specific tRNA.
(B) attaches a specific amino acid to any available tRNA species.
(C) attaches the amino acid at the 5′ end of the tRNA.
(D) catalyzes formation of an ester bond.
(E) splits ATP to ADP + P_i.

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