

***NATIONAL UNIVERISTY OF LESOTHO***

***FACULTY OF HEALTH SCIENCES***

***DEPARTMENT OF PHARMACY***

***BASIC BIOCHEMISTRY (FHS 2302)***

***FINAL EXAMINATION***

**TIME: 3 HOURS**

**JANUARY 2024**

**100 MARKS**

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**INSTRUCTIONS:**

**Answer all questions by giving a letter corresponding to a correct answer**

## ENZYMES

1. What is the general mechanism by which enzyme acts?
  - A. Reducing the activation energy
  - B. Increasing activation energy
  - C. Decreasing pH value
  - D. Increasing the pH value
2. What is the characteristic of a coenzyme?
  - A. Often a metal
  - B. Always a protein
  - C. Often a vitamin
  - D. Always an inorganic compound
3. What is an enzyme that joins the ends of two strands of nucleic acid?
  - A. Polymerase
  - B. Ligase
  - C. Synthetase
  - D. Helicase
4. In a Lineweaver-Burk Plot, competitive inhibitor shows which of the following effect?
  - A. It moves the entire curve to the right
  - B. It moves the entire curve to the left
  - C. It changes the x-intercept
  - D. It changes the y-intercept
5. Which of the following is produced with the combination of apoenzyme and coenzyme?
  - A. Enzyme substrate complex
  - B. Prosthetic group
  - C. Holoenzyme
  - D. Enzyme product complex
6. Which of the following is true for an uncatalyzed reaction?
  - A. High activation energy
  - B. Low activation energy
  - C. Balanced activation energy
  - D. All of these
7. What is true for a solution that is at a pH of 8 compared to a solution with a pH of 1?
  - A. Has fewer hydrogen ions
  - B. Has more hydrogen ions
  - C. Has an equal number of hydrogen ions
  - D. Is less concentrated
8. What information does a Lineweaver-Burk plot provide that a typical Michaelis-Menten plot does not?
  - A.  $V_i$
  - B.  $K_m$
  - C.  $V_{max}$
  - D. None of these answers

9. What is the most likely effect of a non-competitive inhibitor on a Michaelis-Menten enzyme?
- A. Increase the  $V_{\max}$
  - B. Decrease the  $V_{\max}$
  - C. Increase both the  $V_{\max}$  and the  $K_m$
  - D. Decrease both the  $V_{\max}$  and the  $K_m$
10. With regards to enzyme action, which statement is incorrect?
- A. Malonate is a competitive inhibitor of succinic dehydrogenase
  - B. The substrate binds with the enzyme at its active site
  - C. The non-competitive inhibitor binds the enzyme at a site distinct from that binding the substrate
  - D. Increasing the succinate concentration does not reverse the inhibition of succinate dehydrogenase by malonate
11. Which of the following modifications to an enzyme-catalysed process will change the  $V_{\max}$ ?
- A. Addition of a non-competitive inhibitor
  - B. Addition of a competitive inhibitor
  - C. Increasing substrate to supraphysiological concentrations
  - D. None of these options
12. When an inhibitor binds to an enzyme at a place other than the active site, but only when the enzyme and substrate are already bound in complex, which of the following best represents the situation?
- A. Competitive inhibition
  - B. Allostery
  - C. Uncompetitive inhibition
  - D. Non-competitive inhibition
13. Some people cannot digest milk products because they lack a specific enzyme. Which enzyme would be used to break down the lactose in milk?
- A. Hydroxylase
  - B. Maltase
  - C. Peroxisomes
  - D. Lactase

### ACIDS AND BASES

14. What change in  $[H^+]$  does each number on the pH scale represent?
- A. One point
  - B. Ten-fold
  - C. Hundred-fold
  - D. Ten thousand-fold
15. Which two organs/systems are involved in keeping the bicarbonate buffer system balanced?
- A. Lungs, liver
  - B. Digestive system, circulatory system
  - C. Digestive system, respiratory system
  - D. Kidneys, lungs

16. Which of the following indicates that the  $pK$  of an acid is numerically equal to the  $pH$  of the solution when the molar concentration of the acid and its conjugate base are equal?
- Michaelis-Menten equation
  - Henderson- Hasselbalch equation
  - Haldanes equation
  - All the above
17. Which of the following distinguishes a strong acid from a weak acid?
- How much of it changes into water
  - How much it synthesizes in water
  - How much of it dissociates in water
  - All the above
18. What effect will an increase in the volume of an acid solution have on the  $pH$  and  $pK_a$  of the acid?
- Both  $pH$  and  $pK_a$  will increase
  - $pH$  will increase,  $pK_a$  remains the same
  - $pH$  remains the same,  $pK_a$  decreases
  - Both  $pH$  and  $pK_a$  remain unaltered
19. When an inhibitor binds to an enzyme at a place other than the substrate binding site, but only when the enzyme and substrate are already bound in complex, which of the following best represents the situation?
- Competitive inhibition
  - Allostery
  - Uncompetitive inhibition
  - Non represents such a situation
20. Which of following lowers the percentage of water contained in the body of an individual?
- High fat content
  - Low fat content
  - High protein content
  - Low protein content
21. What is the reason for polar molecules to readily dissolve in water?
- Polar molecules can form ionic bonds with water
  - Polar molecules can replace water-water interaction with more energetically favourable water-solute interactions.
  - Polar charged water can interact with the charge of polar molecules
  - Generally polar molecules will not dissolve in water
22. Which statement is a reason why water expands upon freezing?
- Water molecules take a less defined shape and arrange themselves in two-sided crystalline structures.
  - The hydrogen bonds between water molecules become stronger and cause the water to expand.
  - The hydrogen bonds between water molecules become weaker and cause the water to expand.
  - The hydrogen bonds between water molecules are forming and breaking resulting in expansion.

## HENDERSON HASSELBALCH EQUATION

23. Which of the following is true regarding the Henderson-Hasselbalch equation?
- The pH of the solution is always greater than the pKa of the solution
  - As the ratio of conjugate base to acid increases, the pH increases
  - The hydrogen ion concentration can never equal the acid dissociation constant
  - All the above are true
24. Determine the pH of an aqueous solution of 10 mL of 0.03 M acetic acid,  $CH_3COOH$  and 15 mL of 0.025 M acetate,  $CH_3COO^-$ . pKa of acetic acid is 4.75.
- 4.67
  - 4.83
  - 4.85
  - 3.80
25. Why do buffer solutions resist any change in pH?
- Acids and alkalis in these solutions are shielded from attack by other ions
  - Buffers give unionised acid or base on reaction with added acid or alkali
  - Fixed value of pH
  - Large excess of  $H^+$  or  $OH^-$  ions
26. The Henderson Hasselbalch equation explains the relationship between which of the following parameters? -
- pH and pOH
  - pH and logKa
  - pH and pKa
  - pOH and pKa
27. What is the pH of a buffer solution containing 0.36 M sodium acetate ( $CH_3COONa$ ) and 0.45M acetic acid ( $CH_3COOH$ )? pKa = 4.8.
- 4.7
  - 6.3
  - 5.5
  - 4.2
28. What is the log of the ratio of dissociating acid and associated acid if the pH = pKa?
- It is equal to 10
  - It is zero
  - It is greater than 1
  - It is less than 3
29. What is the status of the acid when the pH equals the pKa?
- Fully dissociated
  - Half dissociated
  - Partially dissociated
  - There is no acid at all
30. Which of the following is true regarding the Henderson-Hasselbalch equation?
- The pH of the solution is always greater than the pKa of the solution.
  - As the ratio of conjugate base to acid increases, the pH increases.
  - The hydrogen ion concentration can never equal the acid dissociation constant.

- A. I and II
- B. II only
- C. I only
- D. II and III

31. What is the ratio of the acid to its conjugate base if a solution of acetic acid ( $pK_a = 4.75$ ) has a pH of 6.75?

- A. 100  $\text{CH}_3\text{COO}^-$  to 1  $\text{CH}_3\text{COOH}$
- B. 100  $\text{CH}_3\text{COOH}$  to 1  $\text{CH}_3\text{COO}^-$
- C. 1  $\text{CH}_3\text{COOH}$  to 100  $\text{CH}_3\text{COO}^-$
- D. 0.01  $\text{CH}_3\text{COOH}$  to 100  $\text{CH}_3\text{COO}^-$

32. How many moles of sodium acetate are needed to produce a buffer with a pH of 5.75 given a solution with 30.0g of acetic acid ( $pK_a=4.75$ )?

- A. 0.3 mol
- B. 5 mol
- C. 0.5 mol
- D. 3 mol

33. What is the  $pH$  of a solution that contains 3.0M hydrofluoric acid and 2.5M fluoride?

Note:  $K_a=6.76 \cdot 10^{-4}$  for hydrofluoric acid.

- A. 3.26
- B. 3.17
- C. 3.00
- D. 3.09

34. Ibuprofen has a  $pK_a$  of 4.91. What is the ratio of  $A^-$  to  $HA$  in the blood ( $pH= 7.4$ )?

- A. 1:114
- B. 1:309
- C. 1:405
- D. 1:220

35. What is the pH of a buffer that contains 0.7M ammonia and 0.9M ammonium chloride?

$pK_a=9.248$

- A. 9.461
- B. 9.527
- C. 9.358
- D. 9.410

## PROTEIN AND PROTEIN METABOLISM

36. Which enzyme catalyzes the first step in the urea cycle?

- A. Carbamoyl phosphate synthetase
- B. Ornithine transcarbamoylase
- C. Urease
- D. Urethase

37. During catabolism of amino acids, what is the release of the amino group is known as?
- Deamination
  - Hydrolysis
  - Ammunition
  - Hydration
38. Where does urea production occur almost exclusively?
- Kidneys
  - Liver
  - Blood
  - Urine
39. Which is the first amino group entering into urea cycle?
- Carbamoyl phosphate
  - Ornithine
  - Citruilline
  - Argininosuccinate
40. What allosterically activates the first enzyme in the urea cycle pathway?
- N-acetylglutamate
  - Acetyl coA
  - Glutamate
  - Carbamoyl phosphate
41. From which compound is the second amino group is transferred to citrulline?
- Aspartate
  - Glutamate
  - Alanine
  - Guanine
42. Nitrogen atoms of urea produced in the urea cycle are derived from which pair of molecules?
- Ammonia and aspartic acid
  - Nitrate
  - Nitrite
  - Ammonia
43. What are the products of urea cycle?
- 1 molecule of urea, 1 molecule of ammonia, 1molecule of ATP and 1molecule of fumarare
  - 1 molecule of urea, 1 molecule of AMP, 2 molecules of ADP and 1 molecule of fumarate
  - 1molecule of aspartic acid, 1molecule of ammonia, 1molecule of ATP and 1molecule of fumarate
  - 2 molecules of urea, 2molecules of ammonia, 1molecule of ATP and 1molecule of fumarate
44. What is the carbon atom source while producing urea in the urea cycle?
- $\text{HCO}_3$
  - Glucose
  - Aspartic acid
  - Arginine

45. Which of the following is not an essential amino acid?
- A. Glycine
  - B. Leucine
  - C. Methionine
  - D. Histidine
46. What does the urea cycle convert?
- A. Keto acids into amino acids
  - B. Amino acids into keto acids
  - C. Ammonia into a less toxic form
  - D. Ammonia into a more toxic form
47. What are the inputs to one cycle of urea cycle?
- A. 1molecule of CO<sub>2</sub>, 1molecule of ammonia, 3 molecules of ATP and 1molecule of aspartic acid
  - B. 1 molecule of urea, 1molecule of AMP, 2 molecules of ADP and 1molecule of fumaric acid
  - C. 1 molecule of aspartic acid, 1molecule of ammonia, 1molecule of ATP and 1molecule of fumarate
  - D. 2 molecules of urea, 2 molecules of ammonia, 1molecule of ATP and 1molecule of fumarate

### **LIPIDS AND LIPID METABOLISM**

48. Which of the following glycolytic intermediates serves as the precursor for the backbone for the synthesis of Triglycerides, Phosphatidylcholine, Phosphatidylethanolamine?
- A. Glyceraldehyde-3-phosphate
  - B. Pyruvate
  - C. 1-3 Bisphosphoglycerate
  - D. 3-Phosphoglycerate
49. Which of the following is associated with the transport of free fatty acids in blood?
- A.  $\beta$ -lipoprotein
  - B. A fatty acid-binding protein
  - C. Albumin
  - D. fatty acids are not transported in blood
50. Where are the enzymes for  $\beta$ -oxidation located?
- A. Nucleus
  - B. Cytosol
  - C. Mitochondria
  - D. Golgi apparatus
51. Where are ketone bodies synthesized?
- A. Brain
  - B. Muscles
  - C. Liver
  - D. Adipose tissues



52. What do the long-chain fatty acids get transported through the inner mitochondrial membrane as?
- A. Acyl-CoA derivative
  - B. Freely
  - C. Carnitine derivative
  - D. Require sodium-dependent carrier
53. Where do the long-chain fatty acids get first activated?
- A. Microsomes
  - B. Mitochondria
  - C. Cytosol
  - D. Nucleus
54. In what compartment does the de novo fatty acid synthesis occur?
- A. Mitochondria
  - B. Peroxisome
  - C. Endoplasmic reticulum
  - D. Cytosol
55. What is the precursor for fatty acid synthesis?
- A. Acetyl CoA
  - B. Propionyl CoA
  - C. Succinyl CoA
  - D. Acetoacetyl CoA
56. The conversion of acetyl CoA to malonyl CoA is the rate-limiting step in fatty acid synthesis. Which of the following enzyme catalyzes the above-mentioned reaction?
- A. Acetyl CoA carboxylase
  - B. Malonyl CoA synthetase
  - C. Acetyl CoA decarboxylase
  - D. Malonyl CoA synthase
57. What is the allosteric regulator of acetyl CoA carboxylase?
- A. Fatty acid
  - B. ATP
  - C. Citrate
  - D. Acetyl CoA
58. Which of the following is not a positive regulator of acetyl CoA carboxylase?
- A. Excess calories
  - B. Insulin
  - C. Citrate
  - D. Long-chain fatty acid
59. What form of energy is required for fatty acid biosynthesis?
- A. ATP
  - B. NADH
  - C. NADPH
  - D. FADH<sub>2</sub>

60. High rate of beta-oxidation in the liver leads to ketogenesis (ketone body synthesis). Which of the following condition may result in ketogenesis?
- A. Uncontrolled Type I diabetes
  - B. Pregnancy
  - C. Starvation
  - D. All of the conditions
61. Which of the following is enzyme is inhibited by malonyl CoA?
- A. Thiokinase
  - B. Carnitine Palmitoyl transferase I
  - C. Acyl CoA Dehydrogenase
  - D. Thiolase
62. What is the role of L-carnitine in fatty acid metabolism?
- A. Facilitate the transport of fatty acid from the cytosol to mitochondria
  - B. Serve as a cofactor for enzyme fatty acid synthase
  - C. Activator of acetyl CoA carboxylase
  - D. None of the answers is correct
63. Which is the correct sequence of enzymes in beta oxidation?
- A. Acyl-CoA dehydrogenase, Enoyl-CoA hydratase, 3-L hydroxyacyl CoA dehydrogenase,  $\beta$ -ketoacyl CoA thiolase
  - B. Enoyl-CoA hydratase,  $\beta$ -ketoacyl CoA thiolase, 3-L hydroxyacyl CoA dehydrogenase, Acyl-CoA dehydrogenase
  - C. Acyl-CoA dehydrogenase  $\beta$ -ketoacyl CoA thiolase, 3-L hydroxyacyl CoA dehydrogenase Enoyl-CoA hydratase
  - D. Acyl-CoA dehydrogenase, Enoyl-CoA hydratase,  $\beta$ -ketoacyl CoA thiolase, 3-L hydroxyacyl CoA dehydrogenase,
64. How many cycles of  $\beta$  oxidation are required to completely degrade a 16 carbon fatty acid?
- A. 9
  - B. 8
  - C. 7
  - D. 2
65. How many molecules of acetylCoA are produced from an 18 carbon fatty acid chain if it undergoes  $\beta$ -oxidation?
- A. 9
  - B. 8
  - C. 7
  - D. 2
66. How many molecules of ATP are produced from a 14 carbon fatty acid chain as it undergoes  $\beta$  oxidation?
- A. 28
  - B. 30
  - C. 36
  - D. 48

67. Assuming the AcetylCoA from the 14 carbon fatty acid chain joins the Kreb's Cycle, what is the total number of ATP molecules produced?
- 84
  - 112
  - 63
  - 28
68. Identify the correct sequential enzymatic step for fatty acid synthesis:
- Delta-2-enoyl CoA Dehydrate, Acyl CoA Dehydrogenase, Hydroxy acyl dehydrogenase, Thiolase
  - Hydroxy acyl dehydrogenase, Acyl CoA Dehydrogenase, Delta-2-enoyl CoA Dehydrate, Thiolase
  - Thiolase, Acyl CoA Dehydrogenase, Delta-2-enoyl CoA Dehydrate, Hydroxy acyl dehydrogenase
  - Acyl CoA Dehydrogenase, delta-2-enoyl CoA Dehydrate, Hydroxy acyl dehydrogenase, Thiolase
69. Which of the following enzymes of fatty acid oxidation is inhibited by malonyl CoA?
- Thiokinase
  - Carnitine Palmitoyl transferase I
  - Acyl CoA Dehydrogenase
  - Thiolase

### **CARBOHYDRATE METABOLISM**

70. Which of the following statements regarding glycogenolysis is not true?
- Glycogenolysis releases glucose into the blood.
  - Glycogenolysis helps correct hypoglycaemia.
  - Glycogenolysis is the formation of carbohydrates from monosaccharides.
  - Glycogenolysis is stimulated by glucagon.
71. Glucose 6-phosphatase is present only in which organ?
- Liver
  - Muscle
  - Epithelial tissues
  - Kidneys
72. Which of the following enzyme catalyzes the first step of glycolysis?
- Hexokinase
  - Pyruvate kinase
  - Glucokinase
  - Phosphofructokinase-1
73. Whenever the cell's ATP supply is depleted, which of the following enzyme's activity is increased?
- Hexokinase
  - Pyruvate kinase
  - Glucokinase
  - Phosphofructokinase-1

74. Cleavage of Fructose 1, 6-bisphosphate yields which compounds?
- A. Two aldoses
  - B. Two ketoses
  - C. An aldose and a ketose
  - D. Only a ketose
75. To which compound is Dihydroxyacetone phosphate rapidly and reversibly converted to?
- A. Glyceraldehyde 3-phosphate
  - B. 1, 3-bis-phosphoglycerate
  - C. Fructose 1, 6-bisphosphate
  - D. Fructose 6-phosphate
76. Which substrate is used in the last step of glycolysis?
- A. Glyceraldehyde 3-phosphate
  - B. Pyruvate
  - C. Phosphoenolpyruvate
  - D. 1, 3-bisphosphoglycerate
77. Which enzyme is inhibited by high concentration of glucose 6-phosphate?
- A. Hexokinase
  - B. Pyruvate kinase
  - C. Glucokinase
  - D. Phosphofructokinase-1
78. Which statement is true for Glycolysis?
- A. It converts glucose into pyruvate
  - B. It converts glucose into phosphoenolpyruvate
  - C. It converts fructose into pyruvate
  - D. It converts fructose into phosphoenolpyruvate
79. Which of the following is not an important precursor of glucose in animals?
- A. Lactate
  - B. Pyruvate
  - C. Glycerol
  - D. Glucose 6-phosphate
80. Which enzyme catalyzes the conversion of pyruvate to oxaloacetate?
- A. Pyruvate carboxylase
  - B. Pyruvate dehydrogenase
  - C. Pyruvate kinase
  - D. Phosphofructokinase-1
81. Which enzyme reduces Oxaloacetate to Malate?
- A. Pyruvate carboxylase
  - B. Malate dehydrogenase
  - C. Pyruvate kinase
  - D. Phosphofructokinase-1

82. What does Gluconeogenesis involve the conversion of?
- A. Glucose to pyruvate
  - B. Pyruvate to glucose
  - C. Phosphoenolpyruvate to glucose
  - D. Pyruvate to fructose
83. Which of the following statements about gluconeogenesis is correct?
- A. Pyruvate is first converted to phosphoenolpyruvate by phosphoenolpyruvate carboxykinase
  - B. Fructose 1, 6-bisphosphatase converts fructose 1, 6-bisphosphate into fructose 1-phosphate
  - C. Glucose 6-phosphatase hydrolyzes glucose 6-phosphate to release glucose into the blood
  - D. Glucose 6-phosphatase hydrolyzes glucose 6-phosphate and is found in liver and muscle
84. Which product of the Krebs Cycle is essential for Oxidative Phosphorylation?
- A. NADPH and ATP
  - B. Acetyl CoA
  - C. CO<sub>2</sub> and oxaloacetate
  - D. NADH and FADH<sub>2</sub>
85. How many molecules of Acetyl CoA does a single-molecule of glucose generate for entry into the Krebs Cycle?
- A. 4
  - B. 3
  - C. 2
  - D. 1
86. Which molecule accepts a Hydrogen from Malate?
- A. FAD<sup>2+</sup>
  - B. NAD<sup>+</sup>
  - C. NADP<sup>+</sup>
  - D. FMN
87. Which intermediate of the Krebs Cycle is utilised in the formation of amino acids?
- A. Citric acid
  - B. Malic acid
  - C. Isocitric acid
  - D.  $\alpha$ -ketoglutaric acid
88. Which of the following causes the Krebs Cycle to take place under aerobic conditions?
- A. Electron transport chain requires aerobic conditions to operate
  - B. Oxygen is a reactant
  - C. Oxygen has a catalytic function
  - D. The Krebs cycle does not require aerobic conditions
89. By which kind of reaction is Acetyl CoA formed from Pyruvate?
- A. Dehydration
  - B. Reduction
  - C. Oxidative decarboxylation
  - D. Dephosphorylation

90. Which of the following metabolites is not formed during the Krebs Cycle?

- A. Lactate
- B. Isocitrate
- C. Succinate
- D. Both (a) and (b)

91  $\text{FAD}^{2+}$  is reduced in which of the reactions of the Krebs Cycle?

- A. Isocitrate to oxaloacetate
- B. Succinyl CoA to Succinate
- C. Fumarate to malate
- D. Succinate to fumarate

### BIOENERGETICS

92. If enthalpy change for a reaction is zero, then  $\Delta G^\circ$  equals to which of the following?

- A.  $-\text{T}\Delta\text{S}^\circ$
- B.  $\text{T}\Delta\text{S}^\circ$
- C.  $-\Delta\text{H}^\circ$
- D.  $\ln k_{\text{eq}}$

93. Which of the following is true for a reaction if  $\Delta G^\circ$  is positive?

- A. The products will be favoured
- B. The reactants will be favoured
- C. The concentration of the reactants and products will be equal
- D. All of the reactant will be converted to products

94. What is the study of energy relationships and conversions in biological systems called?

- A. Biophysics
- B. Biotechnology
- C. Bioenergetics
- D. Microbiology

95. Which of the following best describes the first law of thermodynamics?

- A. Energy is neither created nor destroyed
- B. Energy always moves from system to surroundings
- C. Energy may be transferred from one system to another
- D. The total entropy of a system must increase if a process occurs spontaneously

96. Which of the following statements is false?

- A. The reaction tends to go in the forward direction if  $\Delta G$  is large and positive
- B. The reaction tends to move in the backward direction if  $\Delta G$  is large and negative
- C. The system is at equilibrium if  $\Delta G = 0$
- D. The reaction tends to move in the backward direction if  $\Delta G$  is large and positive

97. What is likely to occur if  $\Delta G^\circ$  of the reaction  $\text{A} \rightarrow \text{B}$  is  $-40\text{kJ/mol}$  under standard conditions?

- A. Reaction will never reach equilibrium
- B. Reaction will not occur spontaneously
- C. Reaction will proceed at a rapid rate
- D. Reaction will proceed from left to right spontaneously

98.  $\Delta G$  is negative for which of the following processes?
- A. Melting of ice and evaporation of water
  - B. Oxidation of nitrogen
  - C. Oxidation of gold
  - D. Burning of chlorine
99. What makes water a liquid at room temperature?
- A. Hydrogen bonds between water molecules
  - B. Covalent bonding
  - C. Noncovalent interactions
  - D. Van der Waals forces of attraction
100. What is the factor that is responsible for salts like NaCl to dissolve in water easily?
- A. Decrease in entropy
  - B. Increase in entropy
  - C. Increase in enthalpy
  - D. Decrease in enthalpy