

NATIONAL UNIVERSITY OF LESOTHO
FACULTY OF HEALTH SCIENCES
DEPARTMENT OF PHARMACY
BASIC BIOCHEMISTRY AND IMMUNOLOGY (FHS 2302)
SUPPLEMENTARY EXAM

Date: August 2023

100 Marks

Time: 3hrs

Instructions:

Answer all questions by choosing the letter corresponding to the correct answer(s)

Cells

1. Which of the following is the heaviest particulate component of the cell?
 - a. Nucleus
 - b. Mitochondria
 - c. Cytoplasm
 - d. Golgi apparatus
2. Which one is the largest particulate of the cytoplasm?
 - a. Lysosomes
 - b. Mitochondria
 - c. Golgi apparatus
 - d. Endoplasmic reticulum
3. Which is the most active site of protein synthesis?
 - a. Nucleus
 - b. Ribosome
 - c. Mitochondrion
 - d. Cell sap
4. Which of the cellular organelles is not involved in waste disposal system of the cell?
 - a. Lysosomes
 - b. Ribosomes
 - c. Nucleolus
 - d. Golgi's bodies
5. On which of the following does the ability of the cell membrane to act as a selective barrier depend?
 - a. The lipid composition of the membrane
 - b. The pores which allow small molecules
 - c. The special mediated transport systems
 - d. Internal membrane enclosing the intracellular compartment
6. Which of the following is not a function of the Golgi apparatus?
 - a. Synthesizes proteins
 - b. Produces ATP
 - c. Provides a pathway for transporting chemicals
 - d. Forms glycoproteins
7. Which organelle is the powerhouse of the cell?
 - a. Nucleus
 - b. Cell membrane
 - c. Mitochondria
 - d. Lysosomes
8. What is the approximate size of a prokaryotic cell?
 - a. 1-5 μm
 - b. 5-10 μm
 - c. 10-19 μm
 - d. 20-30 μm

9. Which of the following is true for the cytoskeleton and organelles in a prokaryotic cell?
 - a. They are absent
 - b. They are present
 - c. They are more compact
 - d. They are less active

10. Which of the following is found in peroxisomes?
 - a. Hydrolase enzymes
 - b. Catalase enzymes
 - c. Granules
 - d. Produce hydrogen peroxide

11. Which of the following are single-membrane cellular organelles or microbodies in eukaryotic cells?
 - a. Peroxisomes
 - b. Lysosomes
 - c. Vesicles
 - d. Endoplasmic Reticulum

12. Which of the following is not common to both prokaryotic and eukaryotic cells?
 - a. Plasma membrane
 - b. Genome of DNA
 - c. Subcellular organelles defined by membranes
 - d. The ability to replicate

13. Which of the following is a characteristic of mitochondria?
 - a. The inner membrane forms cristae and contains small spheres attached by stalks on the inner surface.
 - b. Only the outer membrane has transmembrane systems for translocation of metabolites
 - c. The mitosol is relatively inert metabolically
 - d. Contains mitochondrial DNA and 70S ribosomes

14. Which of the following is true for lysosomal enzymes?
 - a. Usually operate at acidic pH
 - b. Are normally isolated from their substrates by the lysosomal membrane
 - c. Can lead to cellular digestion if the lysosomal membrane is disrupted
 - d. All the above

15. In which of the following do peroxisomes not have a role?
 - a. Oxidation of very long chain fatty acids
 - b. Synthesis of glycerophospholipids
 - c. Synthesize water-soluble proteins
 - d. Hydrolysis of cholesterol esters

16. What is the principal cation in the intracellular fluid?
 - a. Sodium
 - b. Potassium
 - c. Calcium
 - d. Copper

Water

17. Which of the following makes water a liquid at room temperature?
 - a. Noncovalent interactions
 - b. Hydrogen bonds between water molecules
 - c. Van der Waals forces of attraction
 - d. Covalent bonding

18. Which of the following lowers the percentage of water contained in the body of an individual?
 - a. High fat content
 - b. Low fat content
 - c. High protein content
 - d. Low protein content

19. What is the reason for polar molecules to readily dissolve in water?
 - a. Polar molecules can form ionic bonds with water
 - b. Polar molecules can replace water-water interaction with more energetically favourable water-solute interactions.
 - c. Polar charged water can interact with the charge of polar molecules
 - d. Generally polar molecules will not dissolve in water

20. Which statement is a reason why water expands upon freezing?
 - a. Water molecules take a less defined shape and arrange themselves in two-sided crystalline structures.
 - b. The hydrogen bonds between water molecules become stronger and cause the water to expand.
 - c. The hydrogen bonds between water molecules become weaker and cause the water to expand.
 - d. The hydrogen bonds between water molecules are forming and breaking resulting in expansion.

21. In a sample of pure water, only one of the following equations is **always** true at all conditions of temperature and pressure
 - a. $[\text{H}_3\text{O}^+] = 1.0 \times 10^{-7} \text{ M}$
 - b. $[\text{OH}^-] = 1.0 \times 10^{-7} \text{ M}$
 - c. $[\text{H}_3\text{O}^+] = [\text{OH}^-]$
 - d. $[\text{H}_3\text{O}^+] > [\text{OH}^-]$

22. What factors are responsible for a water molecule being a dipole?
 - a. Similarity in electron affinity of hydrogen and oxygen
 - b. Magnitude of the H-O-H bond angle
 - c. Ability of water to hydrogen bond to various chemical structures
 - d. Charge difference in water molecule

23. Hydrogen bonds can be expected to form only between electronegative atoms such as oxygen or nitrogen and a hydrogen atom bonded to
 - a. Carbon
 - b. An electronegative atom
 - c. Hydrogen
 - d. Iodine

24. What is the intracellular compartment the fluid present in ml/kg of body weight?
- 100
 - 250
 - 330
 - 450

Acids, bases and buffers

25. Which of the following causes respiratory acidosis?
- Retention of carbon dioxide
 - Excessive elimination of carbon dioxide
 - Retention of bicarbonate
 - Retention of proteins
26. What is the important buffer system of extracellular fluid?
- Bicarbonate/carbonic acid
 - Disodium hydrogen phosphate/sodium dihydrogen phosphate
 - Plasma proteins
 - Organic Phosphate
27. What is the ratio of bicarbonate: dissolved CO₂ at pH 7.4?
- 1: 1
 - 10: 1
 - 20: 1
 - 40: 1
28. What is the ratio of monohydrogen phosphate:dihydrogen phosphate in a solution containing phosphate buffer at pH 7.4?
- 4: 1
 - 5: 1
 - 10: 1
 - 20: 1
29. A 0.22 M solution of lactic acid (pKa 3.9) was found to contain 0.20 M in the dissociated form and 0.02 M undissociated form. What is the pH of the solution?
- 2.9
 - 3.3
 - 4.9
 - 6.7
30. The pH of body fluids is stabilized by buffer systems. Which compound will be the most effective buffer at physiologic pH?
- Na₂HPO₄ pKa = 12.32
 - Na₂HPO₄ pKa=7.21
 - NH₄OH pKa = 7.24
 - Citric acid pKa = 3.09
31. Which of the following is true when the pH is equal to the pKa?
- The acid is far more than the conjugate base
 - The base is more than the conjugate acid
 - The acid is equal to its conjugate base
 - All the acid has been neutralized

32. What is the pH of a solution whose hydrogen ion concentration is 3.2×10^{-4} mol/L?
a. 3.0
b. 2.5
c. 3.5
d. 4.8
33. What is the pH of a solution whose hydroxide ion concentration is 4.0×10^{-4} mol/L?
a. 5.5
b. 10.6
c. 11.4
d. 12.5
34. What is the pH value of 2.0×10^{-2} mol/L KOH?
a. 1.69
b. 12.3
c. 11.6
d. 2.50
35. What is the pH value of 2.0×10^{-6} mol/L KOH?
a. 8.00
b. 5.68
c. 8.32
d. 12.3
36. At which point does a buffer have the strongest buffering capacity?
a. When the acid is far more than the conjugate base
b. When the base is more than the conjugate acid
c. When the acid is equal to its conjugate base
d. When all the acid has been neutralized
36. 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
37. If normal plasma pH is 7.4 and normal $[\text{CO}_2]$ is 1.2 mM, what is the normal $[\text{HCO}_3^-]$? $\text{pK}_a = 6.1$
a. 20
b. 22
c. 24
d. 28

Lipids and lipid metabolism

38. Which of the following is characteristic of unsaturated fatty acids?
a. Have less oxygen
b. Have double bonds between carbons
c. Have no double bonds between carbons
d. Have more hydrogen

39. Which class of lipids is most abundant in the body?
- Triacylglycerols
 - Fatty acids
 - Phospholipids
 - Cholesterol
40. Which of the following enzyme is responsible for activation of fatty acids?
- Carnitine
 - Pyruvate dehydrogenase
 - Acyl-CoA synthase
 - Hexokinase
41. Which enzyme(s) is/are responsible for hydrolysis of fatty acids from triacylglycerols?
- AcetylCoA carboxylase
 - Cholesterol
 - AcylCoA synthatases
 - Lipases
42. How many ATP molecules are produced when AcetylCoA molecules produced from beta oxidation of a 16 carbon fatty acid chain are further oxidised in the TCA cycle?
- 96
 - 94
 - 84
 - 38
43. How many ATP molecules are produced during complete β -oxidation of a 16 carbon fatty acid chain?
- 33
 - 31
 - 40
 - 38
44. How many AcetylCoA molecules are produced during complete β -oxidation of a 16 carbon fatty acid chain?
- 8
 - 7
 - 12
 - 10
45. How many rounds of beta oxidation are required to completely degrade a 16 carbon fatty acid chain?
- 8
 - 7
 - 6
 - 2

Proteins, amino acids structure

46. The local spatial arrangement of polypeptide backbone atoms without regard to the conformation of its side chains can be called as?
- Primary structure
 - Secondary structure
 - Quaternary structure
 - Aliphatic structure
47. Which of the following describes the quaternary structure of a protein?
- The sequence of amino acids in the polypeptide
 - The coiling or folding of the polypeptide
 - The intertwining of two or more polypeptides chains to form a protein
 - The 3-dimensional appearance of the polypeptide
48. What are described as building blocks for proteins?
- Nucleic acids
 - Amino acids
 - Carboxylic acids
 - Fatty acids
49. Which of the following are correct about a peptide bond?
- It exhibits partial double bond character
 - It is more stable in the *cis* configuration than in the *trans* configuration
 - It has restricted rotation around the carbonyl carbon to nitrogen bond
 - In proline, the nitrogen is attached to the side chain
50. When the amino acid alanine (R-group is CH₃) is added to a solution with a pH of 7.3, alanine becomes?
- A cation
 - Nonpolar
 - A Zwitterion
 - An anion
51. What is the local spatial arrangement of polypeptide backbone atoms without regard of the conformation of its side chains called?
- Primary structure
 - Secondary structure
 - Quaternary structure
 - Aliphatic structure
52. Which of the following is correct for an α -helix?
- Side-chain groups can align to give a polar face
 - Each peptide bond forms two hydrogen bonds
 - There are 3.6 amino acids per turn.
 - The aminoacyl residues form a zigzag pattern
53. Which of the following pairs of amino acids have negatively charged side chains at pH 7.4?
- Glutamic acid and Aspartic acid
 - Leucine and Glycine
 - Histidine and Lysine
 - Phenylalanine and tyrosine

54. In which structures does the carbonyl group of the peptide bonds form hydrogen bonds with the amide nitrogen of another peptide bond four amino acids further down the polypeptide chain?
- β -Sheets
 - α -Carbons
 - α -Helices
 - β -Conformations
55. The primary stabilizing forces in protein secondary structures are the followings except?
- Covalent bonding
 - Hydrogen bonding
 - Hydrophobic bonding
 - Ionic bonding
56. Which of the following describes the quaternary structure of a protein?
- The sequence of amino acids in the polypeptide
 - The coiling or folding of the polypeptide
 - The intertwining of two or more polypeptides
 - The 3-dimensional appearance of the polypeptide
57. Which imino acid is found in protein structure?
- Alanine
 - Glycine
 - Proline
 - Tryptophan
58. In a plot of equivalents of OH^- versus pH, pH is ~ 2 when 0.5 equivalent has been used, pH is ~ 6 for 1.5 equivalent and pH is ~ 9.5 for 2.5 equiv. In each case, the point indicated is the midpoint of a steep part of the curve. What amino acid has been titrated?
- Glycine
 - Proline
 - Tyrosine
 - Histidine

Protein and amino acid metabolism

59. Which one of the following is the rate limiting enzyme in the urea cycle?
- Ornithine transcarbamoylase
 - Arginase
 - Carbamoyl phosphate synthetase
 - Argininosuccinase
60. Urea excretes nitrogen atoms from which of the following pairs of compounds?
- Aspartate and ammonia
 - Glutamate and α -ketoglutarate
 - Arginino succinate and fumarate
 - Ornithine and citrulline
61. Which one of the following is not used in the synthesis of carbamoyl phosphate?
- Ammonia
 - Bicarbonate
 - Phosphofructokinase
 - Carbamoyl phosphate synthase

62. Which enzyme catalyses the transfer of an amino group from an amino acid to α -ketoglutarate?
- Glutamate transaminase
 - Phosphoenol pyruvate carboxykinase
 - Endopeptidase
 - Chain-length dependent lipase
63. Which of the following enzyme is responsible for the oxidative deamination of amino acids?
- Transaminase
 - Glutamate dehydrogenase
 - α Ketoglutarate deaminase
 - Malate dehydrogenase
64. Which of the following is required for children and not adults?
- Positive nitrogen balance
 - Negative nitrogen balance
 - Stable nitrogen balance
 - Increased ammonia concentration
65. In which organelles does the urea cycle occur?
- Mitochondria and cytosol
 - Nucleus
 - Nucleolus
 - Endoplasmic reticulum
66. What is the role of the urea cycle?
- To produce energy
 - To rid the body of excess nitrogen
 - To increase blood flow
 - To produce intermediates for other pathways

Enzymes

67. What is the function of enzymes within living systems?
- Structural elements
 - Neurotransmitters
 - Catalysts
 - Ligands
68. In all enzymes, what is true for the active site?
- Contains the substrate binding site
 - Contains a metal ion as a prosthetic group
 - Contains the amino acid side chains involved in catalysing the reaction
 - All the above
69. What are enzyme cofactors that bind covalently at the active site of enzymes are referred to as?
- Co-substrates
 - Prosthetic groups
 - Apoenzymes
 - Vitamins

70. What are metabolites of an enzyme-catalysed reaction known as?
- Products
 - Substrates
 - Proteins
 - Cofactors
71. Which functions are performed by metal cations?
- Serve as Lewis acids in enzymes
 - Participate in oxidation-reduction processes
 - Stabilize the active conformation of an enzyme
 - All the above
72. What is the optimal temperature range for most enzymes?
- 40-55 °C
 - 35-40 °C
 - 25-30 °C
 - 55-60 °C
73. What is the rate-determining step of Michaelis-Menten kinetics?
- The Enzyme-Substrate complex formation step
 - The Enzyme-Product complex dissociation step
 - The Enzyme-Product complex formation step
 - Product binding step
74. If an enzyme is described by the Michaelis Menten equation, a competitive inhibitor will?
- Decrease the K_m , but not the V_{max}
 - Always just change the V_{max}
 - Increase the K_m but not change the V_{max}
 - Increase the K_m and V_{max}
75. What is the most likely effect of a non-competitive inhibitor on a Michaelis-Menten enzyme?
- Increase the V_{max}
 - Decrease the V_{max}
 - Increase both the V_{max} and the K_m
 - Decrease both the V_{max} and the K_m
76. In a Lineweaver-Burk Plot, competitive inhibitor shows which of the following effect?
- It moves the entire curve to the right
 - It moves the entire curve to the left
 - It changes the x-intercept
 - It changes the y-intercept
77. Which of the following is true for an uncatalyzed reaction?
- High activation energy
 - Low activation energy
 - Balanced activation energy
 - All the above

Bioenergetics and Oxidative metabolism

78. Which thermodynamic system exchanges both matter and energy with the surroundings?
- Open system
 - Closed system
 - Isolated system
 - None of the above
79. Which of the following constitute the universe?
- System
 - Surroundings
 - System plus surroundings
 - Entropy
80. The first and second laws of thermodynamics are unified by which concept?
- Gibbs free energy
 - Metabolism
 - Adenosine triphosphate
 - All the above
81. Which of the following best describes the second law of thermodynamics?
- Energy is neither created nor destroyed
 - Energy always moves from system to surroundings
 - Energy may be transferred from one system to another
 - The total entropy of a system must increase if a process occurs spontaneously
82. What is entropy?
- The extent of disorder or randomness of the system
 - The amount of heat produced by a system
 - Level of organization in the universe
 - The amount of energy consumed by a system
83. Which of the following describes catabolism?
- Synthesis of molecules from precursors
 - Breakdown of large molecules to yield energy and smaller products
 - Utilization of energy from to form large molecules
 - Synthesis of glycogen from glucose
84. Which of the following is not a characteristic of metabolic pathways?
- Metabolic pathways always have a commitment step
 - Metabolic pathways occur in specialized locations in eukaryotes
 - Metabolic pathways are reversible
 - Metabolic pathways are regulated by enzymes

Carbohydrate metabolism

85. Which enzyme is responsible for oxidative decarboxylation of pyruvate?
- Pyruvate decarboxylase
 - Pyruvate dehydrogenase
 - Succinate dehydrogenase
 - Fumarase

86. Which metabolite links gluconeogenesis to the TCA cycle?
- Acetoacetate
 - Oxaloacetate
 - Citrulline
 - All the above
87. Deficiency of which enzyme results in the glycogen of abnormal structure with short outer branches?
- Branching enzyme
 - Glycogen phosphorylase
 - Glycogen synthase
 - Debranching enzyme
88. Which enzyme causes a storage disease in which there is a deficiency of glycogen?
- Liver glycogen synthase
 - Debranching enzyme
 - Glycogen phosphorylase
 - Muscle phosphofructokinase
89. Which step is the first in the formation of glycogen after phosphorylation of glucose?
- Branching of glycogen units to form a branched polymer
 - Cleavage by substitution of a phosphate group to yield glucose-1-phosphate
 - Combining of glucose-1-phosphate with Uridine Triphosphate (UTP) to form Uridine diphosphate glucose (UDPG)
 - Removal of three units of the branches to form one long chain
90. Which of the following is an allosteric activator of phosphofructokinase?
- ATP
 - AMP
 - Citrate
 - NADH
91. What is the net ATP yield of the glycolytic pathway after glycogenolysis in the muscle?
- 2 ATP molecules
 - 1 ATP molecule
 - 3 ATP molecules
 - 4 ATP molecules
92. Which of the following steps is the commitment step in glycolysis?
- Conversion of DHAP to G3P
 - Aldol cleavage of fructose-1,6-bisphosphate to 3 carbon intermediates
 - Conversion of fructose-6-phosphate to fructose-1,6-bisphosphate
 - Phosphorylation of glucose by ATP to form glucose-6-phosphate
93. Which of the following is an allosteric activator of glycogen phosphorylase in the muscle?
- GTP
 - AMP
 - ATP
 - Insulin

94. Which of the following is an allosteric inhibitor of hexokinase?
- Glucose-6-phosphate
 - ATP
 - AMP
 - Fructose-2,6-bisphosphate
95. Which product results from glycolysis under anaerobic conditions?
- Pyruvate
 - Lactate
 - Oxaloacetate
 - Dihydroxyacetone Phosphate
96. What is the reason for the phosphorylation of glucose in the first step of glycolysis?
- To prevent the escape of glucose out of the cell
 - To utilize the molecule of ATP
 - To increase the amount of glucose inside the cell
 - To increase blood glucose levels
97. Which of the following enzymes in glycogenolysis is located exclusively in the liver?
- Glycogen synthase
 - Glucose-6-phosphatase
 - Branching enzyme
 - Glycogen phosphorylase
98. Which organ stores most glycogen?
- Liver
 - Spleen
 - Pancreas
 - Muscle
99. What is the importance of branching in the molecule of glycogen?
- To enhance storage capacity
 - To increase amount of glucose mobilized per unit time
 - To help increase size of the muscles
 - To increase the size of the liver
100. Which of the following is a possible result of a deficiency in glycogen phosphorylase?
- Inability of glycogen breakdown
 - Decreased blood glucose
 - Increased ATP
 - Decreased rate of glycogen formation