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(3 pts)
1) Given the following biochemical building blocks, fill in the appropriate biopolymer.
   a. fatty acids
   b. amino acids
   c. monosaccharides
   d. nucleotides

(4 pts)
2) For the following cellular functions, list the organelle which is *most likely* to be responsible for getting the job done.
   a. generates $O_2$, fixes $CO_2$
   b. consumes $O_2$, generates ATP
   c. protein synthesis
   d. phospholipid biosynthesis

(2 pts)
3) *Briefly* describe (20 words or less) the defining difference between eukaryotic and prokaryotic cells.

(2 pts)
4) Using the following molecule, show or explain a hydrogen bond

\[
\begin{array}{c}
H \quad O-H \\
\H \quad H-C-C-N-C-C-O-H
\end{array}
\]

(3 pts)
5) Explain *briefly* (30 words or less) the nature of hydrophobic interactions.
6) Which of the following geometries best describes the bonding behavior of oxygen in H₂O?
   a. linear
   b. trigonal planar
   c. tetrahedral

(4 pts)
7) Water has a melting temp of 0°C and a boiling temp of 100°C, while NH₃ has a melting temp of -78°C and a boiling temp of -33°C. Explain why these two molecules of nearly the same molecular mass have such different melting & boiling temps.

(3 pts)
8) Which of the following is the least true?
   a. a buffer always resist changes in pH
   b. pure H₂O is not an effective buffer
   c. a buffer is most effective when the solution is within 1 pH unit of its pKₐ

(4 pts)
9) Which of the following is considered to be the Henderson-Hasselbalch equation?
   a. pH = pKₐ - log[A⁻]/[HA]
   b. pH = pKₐ - log[HA]/[A⁻]
   c. pH = pKₐ + log[H⁺]/[A⁻]
   d. pH = pKₐ - log[H⁺]/[A⁻]
10) Which of the following structures is known as the “guanido” group. Circle the correct answer.

\[ \text{Structure A} \quad \text{Structure B} \quad \text{Structure C} \quad \text{Structure D} \]

11) Choose the best description regarding the side group of each amino acid listed on the right. Assume that these amino acids are in a solution buffered to pH 8.0.

_____ has a positively charged amino group
_____ has a negatively charged carboxylate group
_____ hydrophobic and aromatic
_____ saturated hydrocarbon
_____ contains sulfur

A. Glutamine  
B. Tryptophan  
C. Methionine  
D. Isoleucine  
E. Lysine  
F. Aspartate  
G. none of the above amino acids

12) Draw a tripeptide (any 3 amino acids of your choice) in the “trans configuration.” Use arrows to show which bonds are peptide bonds.
13) Provide the full name (correct spelling), three letter code and one letter code for each of the four following amino acids.

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<tr>
<th>Name</th>
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14) The following peptide was treated separately with three different proteases. Identify the peptide products of the 3 separate experiments.

a. CNBr treatment

b. trypsin treatment

c. chymotrypsin treatment

15) a. What is the function of SDS in SDS PAGE?

b. What is the function of β-Mercapto ethanol (β-ME) in SDS PAGE?

c. SDS PAGE is an acronym. Provide the entire name for SDS PAGE.

16) What is the isoelectric point of a molecule?

How is the isoelectric point utilized in isoelectric focusing?
(3 pts)
17) Match the following with the most appropriate level of protein structure.

_____ α-helix
_____ linear amino acid sequence
_____ spatial arrangement of myoglobin’s 8 α-helices

A. primary structure
B. secondary structure
C. tertiary structure
D. quaternary structure

(3 pts)
18) Which of the following is least true about α-helix structure.
   a. amino acid side chains stick out from the helix
   b. the rise along the helix is ~3.6 amino acids per turn
   c. hydrogen bonding occurs between adjacent helices

(4 pts)
19) In terms of hydrogen bonding, explain the difference between the α-helix and β-sheet structures. What is the contribution of amino acid side chains to the hydrogen bonding? A brief explanation is preferred.

(3 pts)
20) A cystine
   a. contains a disulfide bond
   b. is formed by nucleophilic acyl substitution
   c. is one of the 20 common amino acids
21) The crystal structure of myoglobin (& later other globular proteins) revealed that the hydrophobic amino acids & hydrophilic amino acids were found in distinct locations. Describe these locations.

22) What is the primary function of the distal His in either myoglobin or hemoglobin?

23) Which of the following best demonstrates the allosteric behavior of Hemoglobin?
   a. it can bind up to four O₂ molecules per protein
   b. binding of the 1st O₂ enhances binding of the 2nd O₂
   c. binding of CO prevents the binding of O₂

23) Use this diagram to show the effect of higher pH on O₂ binding in hemoglobin.

24) Which of the following is the least true regarding sickle cell anemia?
   a. red blood cells form a sickle shape when O₂ is depleted
   b. 2 α-helices are converted to β-pleated sheet (β-strands) structure
   c. it results from a single amino acid substitution (Glu → Val)
(4 pts)
25) We covered quite a bit of material & I didn’t have space to ask all the questions that I wanted and probably left out a good one and I bet you knew the answer. For 4 points, write a question (it can be brief) regarding a topic from the first 10 lectures and provide the correct answer (this can also be brief). {Hint: Lecture 10 was under-represented on this exam}
BONUS QUESTION: For up to 4 extra points, answer only option 1 or option 2 (do not answer both).

Bonus Option 1: Two proteins, A and B, are moving in an electric field. After one hour, protein A stops moving but protein B continues to move. Explain this observation.

Bonus Option 2: Arginine behaves as a triprotic acid (3 different functional groups can carry or lose a proton). Draw each of the four different protonated states of this amino acid.