Biochemistry Quiz Review II   Fall 2019

A general note: Short answer questions are just that, short. Writing a paragraph filled with every term you can remember from class won't improve your answer— just answer clearly, succinctly, and in your own words.

1. Of the 20 standard amino acids, only _____ is not optically active. The reason is that its side chain _____.

A. alanine; is a simple methyl group
B. glycine; is a hydrogen atom
C. glycine; is unbranched
D. lysine; contains only nitrogen
E. proline; forms a covalent bond with the amino group

2. Two amino acids of the standard 20 contain sulfur atoms. They are:

A. cysteine and serine
B. cysteine and threonine
C. methionine and cysteine
D. methionine and serine
E. threonine and serine

3. In a highly basic solution, pH = 13, the dominant form of glycine is:

A. NH_2—CH_2—$COOH$
B. NH_2—CH_2—$COO-$
C. NH_2—CH_3^+—$COO-$
D. NH_3^+—CH_2—$COOH$
E. NH_3^+—CH_2—COO^-

4. An octapeptide composed of four repeating glycylalanyl units has:

A. one free amino group on an alanyl residue
B. one free amino group on an alanyl residue and one free carboxyl group on a glycyl residue
C. one free amino group on a glycyl residue and one free carboxyl group on an alanyl residue
D. two free amino and two free carboxyl groups
E. two free carboxyl groups, both on glycyl residues

5. In a mixture of the five proteins listed below, which should elute second in size-exclusion (gel-filtration) chromatography?

A. cytochrome *c*   m.w. =   13,000
B. immunoglobulin G   m.w. = 145,000
C. ribonuclease A   m.w. =   13,700
D. RNA polymerase   m.w. = 450,000
E. serum albumin   m.w. =   68,500

6. Which of the following refers to particularly stable arrangements of amino acid residues in a protein that give rise to recurring patterns?

A. Primary structure
B. Secondary structure
C. Tertiary structure
D. Quaternary structure
E. None of the above

7. All of the following are considered "weak" interactions in proteins, *except:*

A. hydrogen bonds
B. hydrophobic interactions
C. ionic bonds
D. peptide bonds
E. van der Waals forces

8. Which of the following best represents the backbone arrangement of two peptide bonds?

A. C—N—C—C—C—N—C—C
B. C—N—C—C—N—C
C. C—N—C—C—C—N
D. C—C—N—C—C—N
E. C—C—C—N—C—C—C

9. A D-amino acid would interrupt an α helix made of L-amino acids. Another naturally occurring hindrance to the formation of an α helix is the presence of:

A. a negatively charged Arg residue
B. a nonpolar residue near the carboxyl terminus
C. a positively charged Lys residue
D. a Pro residue
E. two Ala residues side by side

10. Analysis of x-ray diffraction data yields a(n) _____; analysis of 2D NMR data yields a(n) _____.

A. electron density map; count of hydrogen atoms in the molecule
B. shadow of protein's outline; estimate of protein's molecular volume
C. table of interatomic distances; electron density map
D. electronic density map; table of interatomic distances
E. 3-d protein structure; 2-d protein structure

11. The amino acid substitution of Val for Glu in Hemoglobin in sickle cell anemia (Hemoglobin S) results in aggregation of the protein because of _____ interactions between molecules.

A. covalent
B. disulfide
C. hydrogen bonding
D. hydrophobic
E. ionic

12.   You need to make 300 mL of 0.20 M Acetic Acid buffer at pH 5.4. You find an available stock bottle of 1.00 M Acetic Acid at pH 4.76 (pKa 4.76). You also have stocks of 5.00 M HCl, 5.00 M NaOH, and ddH$_2$O. Which chemicals do you need to add, and what volume?

13. In your own words, what is an enantiomer?

14.   Draw the amino acid Glutamic Acid:

15.   1   2   3   4   5
    _____
         Asp-Glu   Gly-Arg   Trp-Tyr   His-Glu   Leu-Val

Which one of the above dipeptides (1 through 5):
        (a) Is most negatively charged at pH 7?

        (b) Contains the largest number of nonpolar R groups?

16. Glycine has two dissociable protons: one with a pKa of 2.3, the other with a pKa of 9.6. Draw the structure of Glycine and indicate where these protons are attached.

17. Under what pH range or ranges would glycine have good buffering power?

18. When proteins are purified by gel electrophoresis, SDS (sodium dodecyl sulfate) is often included with the protein. What is the purpose of this SDS, and what does it enable biochemists to investigate?

19. In your own words, what is the primary structure of a protein?

20. Describe the general shape that β strands form. What forces hold the strands in this form?

21. Name two amino acid residues you would not expect to commonly be found in an α helix:

22. What type of amino acid residue is typically found in the interior of a water-soluble globular protein? Why?

23. Explain why a denatured protein might not refold *in vitro*.

24. Describe the difference between secondary and tertiary structure in proteins.
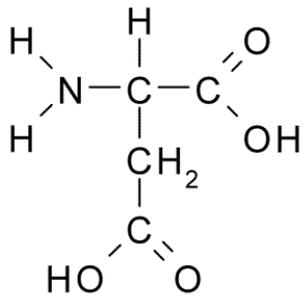
25. β-fibroin is a primarily constituent of silk. In your own words, describe the structure of fibroin on the molecular level.

26. Why does NMR generate multiple, similar structures for a given protein?

27. Chaperones assist in what process?

28. What is a "motif", as applied to protein structure?

29. Name the following amino acids with full name and 1 letter code:
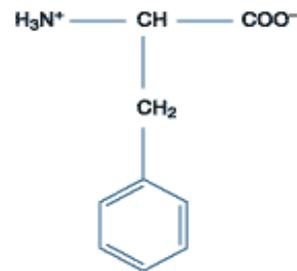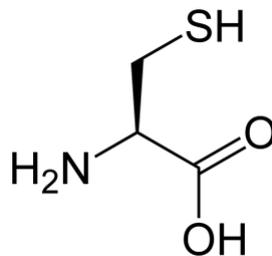
30. Draw the complete tetrapeptide HDTL at pH 7.0:

31. If the free energy change ΔG for a reaction is -46.11 kJ/mol, the reaction is:
A. at equilibrium
B. endergonic
C. endothermic
D. exergonic
E. exothermic

32. In the binding of oxygen to myoglobin, the relationship between the concentration of oxygen and the fraction of binding sites occupied can best be described as:
A. hyperbolic
B. linear with a negative slope
C. linear with a positive slope
D. random
E. sigmoidal

33. The role of an enzyme in an enzyme-catalyzed reaction is to:
A. bind a transition state intermediate, such that it cannot be converted back to substrate
B. ensure that all of the substrate is converted to product
C. ensure that the product is more stable than the substrate
D. increase the rate at which substrate is converted into product
E. make the free-energy change for the reaction more favorable

34. If the $\Delta G'^\circ$ of the reaction A ←→ B is –40 kJ/mol, under standard conditions the reaction:
A. is at equilibrium
B. will never reach equilibrium
C. will not occur spontaneously
D. will proceed at a rapid rate
E. will proceed spontaneously from left to right

35. The interactions of ligands with proteins:
A. are relatively nonspecific.
B. are relatively rare in biological systems.
C. are usually irreversible.
D. are usually transient.
E. usually result in the inactivation of the proteins.

36. When a mixture of glucose 6-phosphate and fructose 6-phosphate is incubated with the enzyme phosphohexose isomerase (which catalyzes the interconversion of these two compounds) until equilibrium is reached, the final mixture contains twice as much glucose 6-phosphate as fructose 6-phosphate. Which one of the following statements is best applied to this reaction outlined below?

    Glucose 6-phosphate ←→ fructose 6-phosphate

A. □$\Delta G'^\circ$ is incalculably large and negative
B. □$\Delta G'^\circ$ is –1.72 kJ/mol
C. □$\Delta G'^\circ$ is zero
D. □$\Delta G'^\circ$ is +1.72 kJ/mol
E. □$\Delta G'^\circ$ is incalculably large and positive

37. In glycolysis, fructose 1,6-bisphosphate is converted to two products with a standard free-energy change ($\Delta G'^\circ$) of 23.8 kJ/mol. Under what conditions encountered in a normal cell will the free-energy change (ΔG) be negative, enabling the reaction to proceed spontaneously to the right?
A. Under standard conditions, enough energy is released to drive the reaction to the right
B. The reaction will not go to the right spontaneously under any conditions because the $\Delta G'^\circ$ is positive
C. The reaction will proceed spontaneously to the right if there is a high concentration of products relative to the concentration of fructose 1,6-bisphosphate
D. The reaction will proceed spontaneously to the right if there is a high concentration of fructose 1,6-bisphosphate relative to the concentration of products
E. None of the above conditions is sufficient

38. Which one of the following statements is true of enzyme catalysts?
A. They bind to substrates, but are never covalently attached to substrate or product
B. They increase the equilibrium constant for a reaction, thus favoring product formation
C. They increase the stability of the product of a desired reaction by allowing ionizations, resonance, and isomerizations not normally available to substrates
D. They lower the activation energy for the conversion of substrate to product
E. To be effective they must be present at the same concentration as their substrates

39. The benefit of measuring the initial rate of a reaction V_0 is that at the beginning of a reaction:
A. [ES] can be measured accurately
B. changes in [S] are negligible, so [S] can be treated as a constant
C. changes in Km are negligible, so Km can be treated as a constant
D. V_0 = Vmax
E. varying [S] has no effect on V_0

40. The amino acid substitution of Val for Glu in Hemoglobin in sickle cell anemia (Hemoglobin S) results in aggregation of the protein because of _____ interactions between molecules.
F. covalent
G. disulfide
H. hydrogen bonding
I. hydrophobic
J. ionic

41. An allosteric interaction between a ligand and a protein is one in which:
A. binding of a molecule to a binding site affects binding of additional molecules to the same site.
B. binding of a molecule to a binding site affects binding properties of another site on the protein.
C. binding of the ligand to the protein is covalent.
D. multiple molecules of the same ligand can bind to the same binding site.
E. two different ligands can bind to the same binding site.

42. Carbon monoxide (CO) is toxic to humans because:
A. it binds to myoglobin and causes it to denature.
B. it is rapidly converted to toxic CO_2.
C. it binds to the globin portion of hemoglobin and prevents the binding of O_2.
D. it binds to the Fe in hemoglobin and prevents the binding of O_2.
E. it binds to the heme portion of hemoglobin and causes heme to unbind from hemoglobin.

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43. How does 2,3-BPG binding to hemoglobin decrease its affinity for oxygen?

44. For an enzyme called "Testase" that catalyzes the reaction A → B, explain the following:
(I) When [Testase] is at 1 mM, the Vmax is found to be 0.5 mM/s. What is the kcat for this enzyme?

(II) When [A] is present at 200 uM, the rate of the reaction (V_0) is found to be 0.1 mM/s. Given that information, what is the Km of this enzyme?

45. Sketch a Lineweaver-Burke graph of typical enzyme reaction, and illustrate what the presence of an uncompetitive inhibitor would likely do as a dotted line.

46. In cystic fibrosis, what cellular process is disrupted?

47. In your own words, why is life an unfavorable process in terms of entropy?

48. For a protein that binds to free fatty acids in the bloodstream (such as $CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-COO^-$), list three R-groups that you might expect to be involved in the binding interaction.

49. In your own words, explain the difference between $\Delta G°'$ and ΔG.

50. The reaction $A + B \rightarrow C$ has a $\Delta G'°$ of +13 kJ/mol. What is the K_{eq}' for this reaction, and does it favor products or reactants? Show your work.

51. Draw an example structure that is a good electrophile, and put a star beside the electrophilic atom. Draw an example structure that is a good nucleophile, and put a # beside the nucleophilic atom.

52. The reaction $A \rightarrow B$ has a Keq of 200. Which is more favorable, A or B? Estimate the $\Delta G'°$ for the reaction.

53. Enzymes are very potent catalysts. In terms of Gibbs free energy, what do enzymes do to the reactions they catalyze?

54. Explain what is wrong with this statement: "For the reaction $S \rightarrow P$, a catalyst shifts the reaction equilibrium to the right."

55. How does life on Earth thrive despite the 2nd law of thermodynamics?

56. Give a working definition of Enthalpy useful for biochemistry.

57. Describe what, in general, is happening during the binding event of an induced fit mechanism.

58. Estimate the affinity of this protein-ligand interaction:
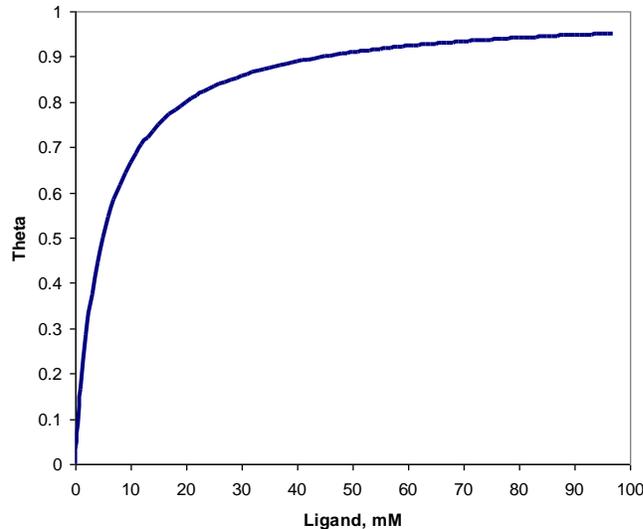
59. For a given binding reaction, if θ is equal to 0.25, and the K_d for the reaction is 1×10^{-4} M, what is the concentration of ligand? Show your work.

60. Describe the difference between a concerted and sequential cooperative mechanism.

61. Given the following data for an enzyme-catalyzed reaction known to follow Michaelis-Menten kinetics, estimate the Km and Vmax. Show how you could use a lineweaver-burke plot to determine these constants.

V_0 (μmol/min)	Substrate added (mmol/L)
217	0.8
325	2
433	4
488	6
647	1,000

62. On a double-reciprocal plot, the Km is derived from which axis intercept?

63. In a plot of 1/V versus 1/S, what will the presence of a competitive inhibitor alter on the graph?

64. How does the total enzyme concentration affect turnover number (kcat) and Vmax?