Questions- Proteins & Enzymes

A. A peptide with 12 amino acids has the following amino acid composition:
2 Met, 1 Tyr, 1 Trp, 2 Glu, 1 Lys, 1 Arg, 1 Thr, 1 Asn, 1 Ile, 1 Cys

Reaction of the intact peptide with fluorodinitrobenzene followed by acid hydrolysis creates a derivative of Ile.
A specific cleavage of the intact peptide produces fragments with the following sequences:

Glu-Cys-Asn-Met-Lys
Met-Glu-Thr-Arg-Trp
Ile-Tyr (Questions 1-5)

1._____ Which reagent was used for the specific cleavage?
a) chymotrypsin
b) trypsin
c) V8 protease
d) cyanogen bromide

2._____ Which amino acids would be released when the intact peptide was treated first with V8 protease followed by treatment with cyanogen bromide?
a) Glu and Met
b) Glu and Lys
c) Met and Lys
d) Glu, Met, and Lys

3._____ Which treatment would result in the release of Lys and Arg from the intact peptide?
a) trypsin
b) trypsin followed by dansyl chloride
c) trypsin followed by carboxypeptidase
d) trypsin followed by mild acid

4._____ If this intact peptide is sequenced using the Edman degradation, which step will be part of the procedure?
a) The Edman reagent will react with all 12 amino acids simultaneously.
b) Lithium borohydride will react with an α-carboxyl group.
c) Phenylisothiocyanate will react with an α-amino group.
d) Strong acid will be used to cleave off one modified amino acid.

5._____ If this peptide is normally part of a multimeric protein composed of four identical subunits, what procedure might be needed prior to performing the Edman degradation?
a) The four subunits should be separated and sequenced individually.
b) Two specific cleavages should be done to create two sets of fragments.
c) Peptide bonds should be broken using hydrazine.
d) Disulfide bonds should be reduced with mercaptoethanol.

B. A peptide has the following amino acid composition:
2 Met, 2 Phe, 2 Glu, 1 Arg, 1 Lys, 1 Val, 1 Leu, 1 Gly, 1 Ser

Reaction of the intact peptide with dansyl chloride followed by acid hydrolysis creates a derivative of Met.

A specific cleavage of the intact peptide produces fragments with the following sequences:

Fragment A: Glu-Gly-Lys-Phe
Fragment B: Met-Ser-Leu-Arg
Fragment C: Met-Val-Glu-Phe (Questions 6-10)

6._____ Which reagent was used for the specific cleavage?
a) cyanogen bromide
b) V8 protease
c) chymotrypsin
d) trypsin

7._____ Which reagent would break only one peptide bond in the intact peptide?
a) cyanogen bromide
b) V8 protease
c) chymotrypsin
d) trypsin

8._____ Which amino acid would be released if the intact peptide was treated with a combination of trypsin and chymotrypsin?
a) Lys
b) Phe
c) Glu
d) Met

9._____ What information do these result give about the sequence of the peptide?
a) The sequence is: Met-Val-Glu-Phe-Glu-Gly-Lys-Phe-Met-Ser-Leu-Arg
b) The sequence is: Met-Ser-Leu-Arg-Met-Val-Glu-Phe-Glu-Gly-Lys-Phe
c) The sequence is: Met-Val-Glu-Phe-Met-Ser-Leu-Arg-Glu-Gly-Lys-Phe
d) The sequence is: Met-Ser-Leu-Arg-Glu-Gly-Lys-Phe-Met Val-Glu-Phe

10._____ This peptide is one polypeptide chain of a multimeric protein that contains two non-identical subunits. What problem might be seen when analyzing the primary structure of the protein if the subunits were not separated?
a) Fluorodinitrobenzene might react with two different amino acids.
b) Carboxypeptidase might not react with the C-terminals.
c) Mercaptoethanol might not reduce disulfide bonds.
d) Lithium borohydride might cleave peptide bonds randomly.

C. Protein A is an α-keratin while Protein B is a transport protein. (Questions 11-15)

11._____ Which characteristic could be shared by Protein A and Protein B?

a) Both could be fibrous proteins containing multiple polypeptide chains.
b) Both could be globular proteins with similar primary structures.
c) Both could contain disulfide bridges linking methionine residues.
d) Both could contain hydrogen bonds between peptide bond atoms.

12._____ When comparing Protein A to a β-keratin

a) the α-keratin has a parallel structure while the β-keratin has an antiparallel structure.
b) the α-keratin has a compact structure while the β-keratin has a more extended structure.
c) both have similar secondary structures that are low-energy states for the proteins.
d) both contain hydroxyproline which functions as a prosthetic group.

13._____ When comparing Protein B to collagen,

a) both are stabilized by van der Waals interactions.
b) both are stabilized by extensive regions of left-handed coils.
c) both contain regions of random secondary structures.
d) both contain α-helices as well as β-pleated sheets.

14._____ Which interaction is likely to occur in Protein B?

a) A hydrophobic interaction could form between the R-groups of Val and Leu.
b) A hydrogen bond could form between the R-groups of Ser and Phe.
c) A salt bridge could form between the R-groups of Arg and His.
d) An ionic bond could form between the R-groups of Gln and Trp.

15._____ When comparing Protein A to Protein B,

a) both could be denatured by using heat to break amide bonds.
b) both could have primary structures that form with the help of chaperones.
c) both have conformations stabilized by numerous non-covalent bonds.
d) both contain the same proportions of hydrophilic and hydrophobic R-groups.

D. Protein A is a structural component while Protein B is an enzyme. The secondary structures of both proteins are studied. (Questions 16-19)

16._____ Which could be characteristics of Protein A and Protein B?

a) Protein A could have a low energy conformation while Protein B could have a high energy conformation.
b) Protein A could be a globular protein while Protein B could be a fibrous protein.
c) Protein A could contain mainly α-helix while Protein B could contain equal amounts of α-helix and β-sheet.
d) Protein A could be a type of collagen while Protein B could be a type of keratin.

17._____ Which could be found within the structure of Protein B?

a) A disulfide bond could form between two prosthetic groups.
b) A salt bridge could form between two chaperones.
c) Protein B could contain areas of random secondary structure stabilized by van der Waals forces.
d) Protein B could contain areas of repeating secondary structure stabilized by hydrogen bonds.

18._____ Which is a characteristic of both an α-helix and a β-pleated sheet?

a) Both can be anti-parallel structures.
b) Both form interactions involving the oxygens of peptide bonds.
c) Both are found only within multimeric proteins.
d) Both are denatured when heat breaks peptide bonds.

19._____ Which is a difference between an α-helix and a β-pleated sheet?

a) An α-helix is a right-handed structure containing disulfide bonds while a β-pleated sheet is a left-handed structure containing ionic bonds.
b) An α-helix has a relatively extended spiral shape while a β-pleated sheet has a relatively compact zig-zag shape.
c) An α-helix has non-covalent bonds between amino acids near each other in the sequence while a β-pleated sheet has non-covalent bonds between amino acids far apart in the sequence.
d) An α-helix contains mainly amino acids with polar R-groups while a β-pleated sheet contains mainly amino acids with non-polar R-groups.

E. Two proteins, myoglobin and hemoglobin, are compared. (Questions 20-30)

20._____ Which characteristics are shared by these two proteins?

a) They both are globular proteins containing the common amino acids, porphyrin, and iron.
b) They both have closely related primary, secondary, tertiary, and quaternary structures.
c) They both are composed of multiple subunits each of which contains a heme prosthetic group.
d) They both have similar molecular weights and bind one oxygen molecule per protein molecule.

21._____ Which is a property of protein tertiary structure?

a) Tertiary structures usually contain hydrocarbon R-groups in the interior of the protein where they can form hydrogen bonds.
b) Tertiary structures usually contain hydroxyl R-groups on the exterior of the protein where they can favorably interact with water.
c) A protein's tertiary structure can be predicted if the amino acid sequence is known by performing the Edman degradation.
d) A protein's tertiary structure can be maintained by covalent salt bridges and non-covalent disulfide bridges.

22._____ Which is a characteristic of protein quaternary structure?

a) A protein composed of identical subunits has quaternary structure but not tertiary structure.
b) A protein composed of non-identical subunits contains two polypeptide chains with opposite charges.
c) The quaternary structure of a multimeric protein always includes covalent crosslinks between the subunits.
d) The quaternary structure of a multimeric protein always depends upon the primary structure of the subunits.

23._____ Which is a property of tertiary structure and quaternary structure?

a) Both structures are stabilized by numerous covalent hydrophobic and hydrophilic interactions.
b) Both structures have specific shapes that depend upon the amino acid sequence of the protein.
c) Both structures form so that polar amino acid R-groups are found mainly in the interior of the protein.
d) Both structures must contain multiple α-helices and β-pleated sheets connected by turns.

24._____ Which property is shared by both myoglobin and hemoglobin?

a) Both are saturated with oxygen at low oxygen concentrations.
b) Both display cooperative binding when transporting oxygen.
c) Both contain strands of β-pleated sheet with a zig-zag shape.
d) Both contain segments of α-helix with a spiral shape.

25._____ Which occurs when a hemoglobin molecule binds oxygen?

a) Oxygen molecules in the lungs bind irreversibly to the protein's heme groups.
b) The second oxygen molecule binds more easily than the first oxygen molecule.
c) The α subunits bind oxygen while the β subunits control cooperativity.
d) Ionic bonds form between subunits which changes the quaternary structure.

26._____ Which change occurs when a hemoglobin subunit binds oxygen?

a) A histidine residue changes position within the subunit.
b) An iron atom is removed from a porphyrin group.
c) The oxygen binds to amino acids within a segment of α-helix.
d) The oxygen causes a covalent crosslink to form within the subunit.

27._____ Which occurs when a hemoglobin molecule binds oxygen in the lungs?

a) Each iron-porphyrin group can reversibly bind four oxygen molecules.
b) Salt bridges between subunits break as the first oxygen binds.
c) The first oxygen molecule binds more easily than the last oxygen molecule.
d) Cooperative binding of oxygen causes the four subunits to dissociate.

28. _____ When myoglobin is denatured using heat

a) its amino acid composition will change.
b) its amino acid sequence will change.
c) its tertiary structure will change.
d) its C-terminal will change.

29._____ When hemoglobin is treated with urea and β-mercaptoethanol

a) its molecular weight will be unchanged.
b) its quaternary structure will be unchanged.
c) its primary structure will be unchanged.
d) its conformation will be unchanged.

30._____ Protein Z functions as an oxygen transport protein, and shares 60% of its primary structure with myoglobin while the other 40% is different. Which is likely to be a characteristic of Protein Z?

a) It probably contains one heme group that can bond two oxygen molecules.
b) It probably contains both α subunits and β subunits.
c) It probably could function even if a mutation changes one of the amino acids in part of the primary structure that is shared with myoglobin.
d) It probably could function even if a mutation changes one of the amino acids in part of the primary structure that is different from myoglobin.

F. Enzyme X and Enzyme Y are both involved in monosaccharide metabolism. Enzyme X uses glucose as a substrate while Enzyme Y uses fructose as a substrate. At pH=7.0, Enzyme X has a Vmax of 10 μM/s while Enzyme Y has a Vmax of 20 μM/s. Both enzymes have a K_M of 3.0 mM for their respective substrates.(Questions 31-37)

31._____ Which aspects of its reaction will be changed by Enzyme Y?

a) the activation energy of the reaction and the energy of the product
b) the rate of the reaction and the energy of the transition state
c) the equilibrium position of the reaction and the energy of the substrate
d) the reversibility of the reaction and the energy of the active site

32._____ When its reaction is carried out at pH = 2.0, the Vmax of Enzyme X is 1.0 μM/s because

a) the enzyme is inhibited by its product at low pH.
b) the enzyme is saturated with substrate at low pH.
c) the enzyme is able to stabilize the transition state at low pH.
d) the enzyme is partially denatured as R-groups protonate at low pH.

33._____ When the reaction is carried out at pH = 7.0 and the substrate concentration is equal to the K_M value

a) X will produce more product than Y.
b) Y will produce more product than X.
c) X and Y will produce the same amount of product.
d) X and Y will both work at their Vmax value.

34._____ Enzyme Y can also use the monosaccharide galactose as a substrate with a K_M of 8.0 mM. Which will be a characteristic of Y as it binds galactose compared to its binding to fructose?

a) Y will form more non-covalent bonds with galactose.
b) Y will form more covalent bonds with galactose.
c) Y will have an active site that is less complementary to galactose.
d) Y will undergo a greater conformational change as it binds galactose.

35._____ Which interaction is likely to occur as Enzyme X carries out its reaction?

a) A hydrogen bond could form between a serine R-group in the active site and a carbonyl group in the transition state.
b) An ionic bond could form between a glutamate R-group in the active site and a carboxyl group in the substrate.
c) A hydrophobic interaction could form between an asparagine R-group in the active site and a methyl group in the substrate.
d) A hydrogen bond could form between a valine R-group in the active site and a hydroxyl group in the transition state.

36._____ Which kinetic property would Enzyme X display as it binds its normal substrate and catalyzes its reaction?

a) It could have an initial velocity independent of [S] when [S] < K_M.
b) It could have a K_M value that decreases as [S] decreases from 3.0 mM to 0.3 mM.
c) It could double the rate of its reaction as [S] increases from 3.0 mM to 30 mM.
d) It could have a Vmax value that is dependent on [S] when [S] < K_M.

37._____ Enzyme Y is allosterically inhibited by ribose and also inhibited by covalent modification with phosphate. Which is a characteristic of its regulation?

a) Y can covalently bind both ribose and phosphate to specific amino acids within the protein.
b) Y can establish an equilibrium with either ribose or phosphate to reduce the activity of the enzyme.
c) Y can bind both ribose and phosphate to a regulatory subunit with the help of extra enzymes.
d) Y can undergo reversible conformational changes when either ribose or phosphate binds to the enzyme.

G. The reactions of two enzymes, Enzyme A and Enzyme B, are studied at pH = 7.0. Both enzymes produce glucose and have the same V_{max}. Enzyme A has a K_M of 2.0 mM while Enzyme B has a K_M of 5.0 mM. (Questions 38-44)

38. _____ Which characteristic will be shared by these two enzymes?

a) Both will increase the rate of their reaction by increasing the energy of the substrate molecules.
b) Both will properly orient the substrate for their reaction by forming covalent bonds with the substrate.
c) Both will decrease the activation energy of their reaction by being complementary to the transition state.
d) Both will shift the equilibrium of their reaction by lowering the energy level of the product.

39. _____ Which property will Enzyme A likely have in common with most other enzymes?

a) It can bind the substrate reversibly using specific amino acids.
b) It can contain a dozen active sites each of which can bind a substrate molecule.
c) It can undergo a small change in primary structure as the substrate binds.
d) It can be required in stoichiometric amounts in order to bind the correct substrate.

40. _____ When Enzyme B carries out its reaction with a substrate concentration of 5.0 mM, the reaction velocity gradually decreases 5 minutes after the reaction starts. What could cause this change in reaction rate?

a) Enzyme B catalyzes an irreversible reaction.
b) Enzyme B becomes saturated with substrate.
c) Enzyme B is inhibited by its product.
d) Enzyme B is working at its V_{max} value.

41. _____ Which will occur when Enzyme A and Enzyme B both carry out their reaction at pH = 7.0?

a) Enzyme A will produce more glucose than Enzyme B when [S] = 5.0 mM.
b) Enzyme B will produce more glucose than Enzyme A when [S] = 5.0 mM.
c) V_o for Enzyme A will double as [S] increases from 5.0 mM to 10.0 mM.
d) V_o for Enzyme B will double as [S] increases from 5.0 mM to 10.0 mM.

42. _____ Which kinetic property will be shared by Enzyme A and Enzyme B?

a) Their K_M values will decrease as the substrate concentration decreases.
b) Their V_{max} values will increase as the substrate concentration increases.
c) Their K_M values will depend upon the concentration of the enzymes.
d) Their V_{max} values will depend upon the slowest step of their reaction mechanisms.

43. _____ The substrate for Enzyme A is a sugar phosphate while the substrate for Enzyme B is a sugar alcohol. Which amino acid is likely to be found in the active site of both enzymes?

a) leucine
b) tryptophan
c) aspartate
d) glutamine

44. _____ Enzyme A is an allosteric enzyme inhibited by galactose while Enzyme B is a covalently modified enzyme inhibited by phosphate. Which will occur during their regulation?

a) Enzyme B will become more inhibited as the concentration of phosphate increases.
b) Enzyme A will become more inhibited as the concentration of galactose increases.
c) Both enzymes will undergo an irreversible conformational change as their regulating molecule binds.
d) Both enzymes will bind their regulating molecule to a specific active site on a catalytic subunit.
