Example 1

MULTIPLE CHOICE:

Choose the most appropriate answer and **enter it on the answer sheet**

1. 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.

2. Which one of the following statements is true of enzyme catalysts?

   A) Their catalytic activity is independent of pH.
   B) They are generally equally active on D and L isomers of a given substrate.
   C) They can increase the equilibrium constant for a given reaction by a thousand fold or more.
   D) They can increase the reaction rate for a given reaction by many thousand fold or more.
   E) To be effective, they must be present at the same concentration as their substrate.

3. A small molecule that *decreases* the activity of an enzyme by binding to a site other than the catalytic site is termed a(n):

   A) allosteric inhibitor.
   B) alternative inhibitor.
   C) competitive inhibitor.
   D) stereospecific agent.
   E) transition-state analog.

4. The cleavage of a peptide bond between two amino acids is an example of a(n) _____ reaction.

   A) condensation
   B) hydrolysis
   C) group transfer
   D) isomerization
   E) oxidation reduction

5. 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.

6. Prosthetic groups in the class of proteins known as glycoproteins are composed of:

   A) carbohydrates.
   B) flavin nucleotides.
   C) lipids.
   D) metals .
   E) phosphates.

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

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

8. An octapeptide was determined to have the following amino acid composition: $(Lys)_2$, $(Gly)_1$, $(Phe)_2$, His, Leu, Met. The native peptide was incubated with 1-fluoro-2,4-dinitrobenzene (FDNB) (Sanger Method) and then hydrolyzed; 2,4-dinitrophenylglycine was identified by HPLC. When the native peptide was exposed to Pepsin (Cleavage point at amino side of Phe, Trp, Tyr), a pentapeptide, a dipeptide and free glycine were recovered. 2,4-Dinitrophenyl-phenylalanine was recovered from the pentapeptide and also the dipeptide (Sanger Method). Incubation of the native peptide with trypsin (Cleavage points at carboxy side of Lys, Arg) gave a tetrapeptide, a tripeptide, and free Lys. 2,4-Dinitrophenyl-leucine was recovered from the tetrapeptide (Sanger Method). The native sequence was determined to be:

   A) Gly–Phe–Lys–Lys–Leu–Met–Phe–His.
   B) Gly–Leu–Lys–Lys–Phe–Phe–Met-His
   C) Met–Leu–Phe–His–Lys–Lys–Phe–Gly.
   D) Gly–Phe–Leu–Lys–Lys–Met-Phe–His.
   E) Met–Phe-Leu–Lys–Lys–His–Phe–Gly.

9. Compare the following sequences taken from **four** different proteins, and select the answer that best characterizes their relationships. Each protein sequence is segregated into three groups of ten amino acids labeled A, B, and C

	A	B	C
1	DVEKGKKIDIMKCS	GLFGRKTGQAPGYSYT	HTVEKGGKHKTGPNLH
2	DVQRALKIDNNLGQ	GLADRIAYQAKATNEE	HTVEKGAKHKTAPNVH
3	LVTRPLYIFPNEGQ	ALKSSKDLMFTVINDD	HTLEKAAKHKTGPNLH
4	FFMNEDALVARSSN	NLKDSKTYLKPVISET	HQFAASSIHKNAPQFH

   A) Based only on sequences in column B, protein 4 reveals the greatest evolutionary divergence.
   B) Comparing proteins 1 and 2 in column A reveals that these two proteins have diverged the most throughout evolution.
   C) Protein 4 is the protein that shows the greatest overall divergence from protein 1.
   D) Proteins 2 and 3 show a greater evolutionary distance than proteins 1 and 4.
   E) The portions of amino acid sequence shown suggest that these proteins are completely unrelated.

10. The effect of a catalyst on a reaction is to:

    A) Increase the energy of activation
    B) Decrease the energy of activation
    C) Increase the ΔG of the reaction
    D) Increase the ΔG of the reaction
    E) Increase the equilibrium constant

11. The functional differences, as well as differences in three-dimensional structures, between two different enzymes from *E. coli* result directly from their different:

    A) affinities for ATP.
    B) amino acid sequences.
    C) roles in DNA metabolism.
    D) roles in the metabolism of *E. coli*.
    E) secondary structures

12. In an aqueous solution, protein conformation is determined by two major factors. One is the formation of the maximum number of hydrogen bonds. The other is the:

    A) formation of the maximum number of hydrophilic interactions.
    B) maximization of ionic interactions.
    C) minimization of entropy by the formation of a water solvent shell around the protein.
    D) placement of hydrophobic amino acid residues within the interior of the protein.
    E) placement of polar amino acid residues around the exterior of the protein.

13. Which of the following experiments provided the first evidence that the amino acid sequence of a polypeptide chain contains all the information required to fold the chain into its native, three-dimensional structure?

    A) When ribonuclease is treated with urea, it loses its catalytic activity
    B) When denatured ribonuclease is allowed to renature, it regains its catalytic activity
    C) When renatured ribonuclease is allowed to denature, it regains its catalytic activity
    D) Addition of mercaptoethanol causes ribonuclease to regain catalytic activity
    E) Addition of mercaptoethanol causes ribonuclease to lose catalytic activity

14. Hydrogen bonds between amino acids in a polypeptide occur between which chemical groups?

    A) the C=O groups.
    B) the C=O and N-H groups.
    C) the C=O and C-R groups a Pro residue.
    D) the C=O and C-H groups.
    E) the C=O and Cα

15. In feedback inhibition:

    A) an enzyme in a pathway inhibits one of the earlier enzymes in the pathway.
    B) an intermediate in a pathway inhibits one of the earlier enzymes in the pathway.
    C) the initial substrate of a pathway inhibits one of the enzymes in the pathway.
    D) the end product of a pathway inhibits one of the enzymes in the pathway
    E) the last substrate used in a pathway inhibits one of the enzymes in the pathway

16. The secondary structure of a protein may be strongly influenced by amino acid residues that are generally near each other in sequence. This relationship is in contrast the three-dimensional conformation, where the amino acid residues involved are:

    A) always side by side.
    B) often quite distant from each other in sequence.
    C) invariably restricted to about 7 of the 20 standard amino acids.
    D) often on different polypeptide strands.
    E) usually near the polypeptide chain's amino terminus or carboxyl terminus.

17. Proline residues are most likely to occur in which of the following secondary structures?

    A) antiparallel β sheet.
    B) parallel β sheet.
    C) α helix.
    D) α sheet.
    E) β turn.

18. Fibrous proteins differ from globular proteins in that

    A) fibrous proteins tend to serve structural functions, and globular proteins are more likely to be enzymes.
    B) fibrous proteins can often contain several types of secondary structure, whereas globular proteins usually consist largely of a single type of secondary structure.
    C) globular proteins are insoluble in water, and fibrous proteins are usually soluble.
    D) globular proteins are more likely than fibrous proteins to have an elaborate quaternary structure.
    E) globular proteins have polypeptide chains arranged in long strands

19. Which bonds are planar (cannot rotate) in a polypeptide backbone?

    A) C_α-C bonds
    B) C-N bonds
    C) N-$C_\alpha$bonds
    D) C_α-C_α bonds
    E) C-R bonds

20. In what way does the binding of a substrate by an enzyme enhance catalysis?

    A) It increases the interaction of the substrate with water
    B) The binding energy of the enzyme-substrate interaction lowers the activation energy
    C) It increases the entropy between substrates
    D) The binding of a substrate prevents the enzyme from changing conformation
    E) The binding of a substrate prevents the enzyme from binding inhibitors

21. A polypeptide is cleaved into peptides by treatment with trypsin and cyanogen bromide, and the peptides are purified and sequenced. The sequences of the peptides (from N to C-terminus) are shown below. (Note: Trypsin cleaves after K and R residues; cyanogen bromide cleaves after M.)

Trypsin peptides	Cyanogen bromide peptides
T-1 GASMALIK	C-1 EGAAYHDFEPIDPRGASM
T-2 EGAAYHDFEPIDPR	C-2 TKDCVHSD
T-3 DCVHSD	C-3 ALIKYLIACGPM
T-4 YLIACGPMTK	

Based on sequences of the overlapping peptides generated by treatment with trypsin and cyanogen bromide (shown above), which of the peptides could represent the N-terminus of the polypeptide?

A) T-3
B) C-1
C) C-2
D) T-4
E) C-3

22. How does hemoglobin bind O_2 cooperatively?

A) The binding of one molecule of O_2 to one subunit of hemoglobin enhances the assembly of other subunits to form a complete hemoglobin protein.
B) The binding of one molecule of O_2 to one hemoglobin protein enhances the binding of a molecule of O_2 to a different hemoglobin protein.
C) The binding of one molecule of O_2 to one subunit of hemoglobin enhances the affinity of the same subunit for more molecules of O_2.
D) The binding of one molecule of O_2 to one subunit of hemoglobin enhances the affinity of other subunits for O_2.
E) The binding of one molecule of O_2 to one subunit of heme enhances the affinity of heme for iron

23. Which group or groups on a protein contribute most to its overall acid-base properties?

A) The α-amino groups of all nonterminal amino acids
B) The N-terminal α-amino group on the protein
C) The R groups on the protein
D) The C-terminal α-carboxyl group on the protein
E) The α-carboxyl groups of all nonterminal amino acids

24. A protein retained on an affinity chromatography column is usually eluted off the column by

A) gradually increasing the salt concentration of the elution buffer.
B) adding the protein's free ligand.
C) changing the pH of the elution buffer.
D) allowing the retained protein to naturally come off the column after the non-specifically bound proteins have first passed through the resin
E) collecting individual samples of the material coming off the column over a long time

25. When an enzymatic activity is purified from a complex mixture of proteins what usually happens to total protein amount and specific activity during the purification process?

A) Total protein amount and specific activity both increase capillaries.
B) Total protein amount and specific activity both decrease
C) Total protein amount increases and specific activity decreases.
D) Total protein amount decreases and specific activity increases
E) Total protein amount remains constant and specific activity increases

26. The substitution of a single amino acid residue in a protein due to a mutation in the DNA may have the following consequence(s):

A) no change in protein conformation
B) a major change in protein conformation
C) defective folding of the protein resulting in disease
D) any of the above
E) none of the above

27. Kuru, Bovine spongiform encephalopathy (BSE), variant Creutzfeldt-Jakob disease (vCJ) are all examples of:

A) genetically based diseases
B) diseases involving defective and infectious protein
C) diseases caused by mutations in the genome
D) diseases that are spread by animals not humans
E) diseases that cannot be prevented

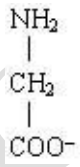
28. The Bohr effect describes which one the following:

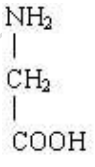
A) an increased affinity of hemoglobin for oxygen at a lower pH
B) an increased affinity of hemoglobin for oxygen at a higher partial pressure of carbon dioxide
C) an decreased affinity of hemoglobin for oxygen at a higher partial pressure of oxygen
D) a decreased affinity of hemoglobin for oxygen at a lower pH
E) a decreased affinity of hemoglobin for oxygen at a higher pH

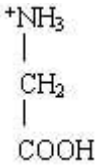
29. Enzymes are potent catalysts because they:

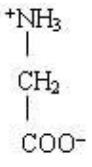
A) are consumed in the reactions they catalyze.
B) are very specific and can prevent the conversion of products back to substrates.
C) drive reactions to completion while other catalysts drive reactions to equilibrium.
D) increase the equilibrium constants for the reactions they catalyze.
E) lower the activation energy for the reactions they catalyze

30. The titration curve of the amino acid glycine reveals a pK_1 of 2.34, a pI of 5.97, and a pK_2 of 9.60. When dissolved in water, which ionic species is most likely to predominate at pH = 5.97?

A) 

B) 

C) 

D) 

E) all of the above

31. What is the biological advantage to the sigmoidal binding curve of hemoglobin for oxygen?

A) It ensures that hemoglobin has a high affinity for oxygen
B) It allows hemoglobin to bind oxygen irreversibly
C) It allows hemoglobin binding to oxygen to be controlled by noncompetitive inhibition
D) It ensures that hemoglobin can bind oxygen only weakly
E) It allows hemoglobin to shift between low and high affinities for oxygen

32. The Bohr effect, the effect of pH and CO_2 concentration on the binding and release of oxygen by hemoglobin, dictates that

A) the binding of CO_2 is inversely related to the binding of H^+
B) the binding of CO_2 is inversely related to the binding of oxygen
C) oxygen binds hemoglobin better at low pH
D) oxygen and H^+ are bound at the same sites in hemoglobin
E) none of the above

33. Which of the following statements about a plot of V_0 vs. [S] for an enzyme that follows Michaelis-Menten kinetics is *false*?

A) As [S] increases, the initial velocity of reaction V_0 also increases.
B) At very high [S], the velocity curve becomes a horizontal line that intersects the horizontal axis at K_m.
C) K_m is the [S] at which $V_0 = 1/2\ V_{max}$
D) The shape of the curve is hyperbolic
E) The vertical axis is a rate term with units of μm/min

34. The optimal complementation in terms of mutual shape or fit between an enzyme and substrate occurs:

A) before they interact
B) following the catalytic conversion of substrate to product
C) before they are inhibited by feedback inhibition
D) during the transition state
E) throughout the enzymatic process

35. The following data were obtained in a study of an enzyme known to follow Michaelis-Menten kinetics:

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

The K_m for this enzyme is approximately:

A) 1 mM.
B) 1,000 mM.
C) 2 mM.
D) 4 mM.
E) 6 mM.

36. The steady state of an enzyme-catalyzed reaction is reached when:

A) the rate of appearance of product over time is constant.
B) the rate of enzyme-substrate formation is constant.
C) the rate of enzyme-substrate conversion to enzyme-product is constant
D) the concentration of enzyme-substrate complex equals the concentration of product.
E) the concentration of the enzyme-substrate complex is constant over time

37. V_{max} for an enzyme-catalyzed reaction:

A) generally increases when pH increases.
B) increases in the presence of a competitive inhibitor.
C) is limited only by the amount of substrate supplied.
D) is twice the rate observed when the concentration of substrate is equal to the K_m.
E) is unchanged in the presence of a uncompetitive inhibitor.

38. Which of the following statements about allosteric control of enzymatic activity is ***false***?

A) Allosteric effectors give rise to sigmoidal V_0 *vs.* [S] kinetic plots.
B) Allosteric proteins are generally composed of several subunits.
C) An effector may either inhibit or activate an enzyme.
D) Binding of the effector changes the conformation of the enzyme molecule.
E) Heterotropic allosteric effectors compete with substrate for binding sites.

39. Allosteric enzymes:

A) are regulated primarily by covalent modification.
B) usually catalyze several different reactions within a metabolic pathway.
C) usually have more than one polypeptide chain.
D) usually have only one active site.
E) usually show strict Michaelis-Menten kinetics.

40. Which of the following is **true** about the Edman degradation system of sequencing polypeptides?

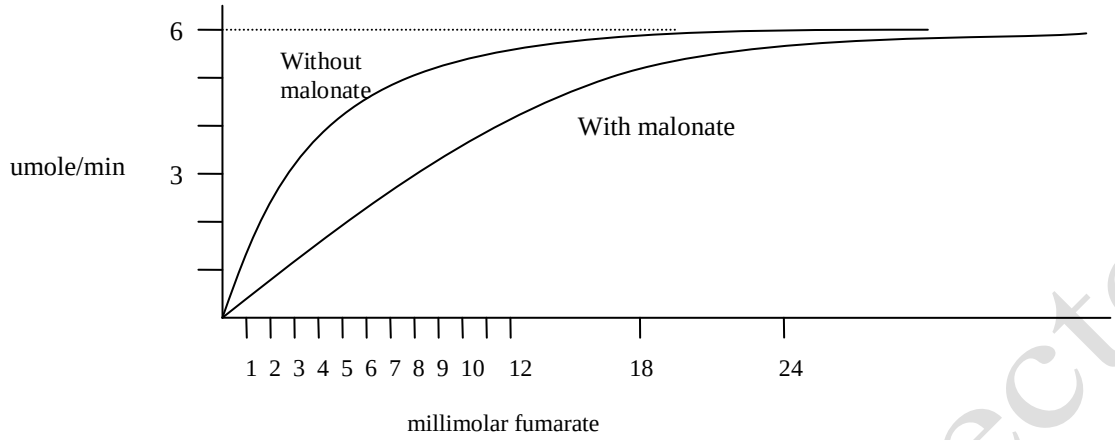
A) The Edman degradation system will work on any size polypeptide.
B) In the Edman degradation system the amino-terminal residue is labeled and the polypeptide is hydrolyzed to its constituent amino acids.
C) In the Edman degradation system the amino-terminal residue is labeled, cleaved and identified in each successive cycle.
D) The Edman degradation system is carried out by hydrolyzing polypeptides to their constituent individual amino acids.
E) In the Edman degradation system the polypeptide is hydrolyzed to its constituent amino acids and the relative amounts of each amino acid are determined

41. In competitive inhibition, increasing concentrations of the inhibitor will have the following effect on the kinetics of the enzyme:

A) K_m will decrease.
B) V_{max} will stay the same.
C) The reaction will cease because the inhibitor binds irreversibly
D) K_m / V_{max} will stay the same
E) V_{max} is halved

The diagram below refers to questions 42-44:

The conversion of fumarate to malate is catalysed by fumarase. The following results were obtained when the reaction was studied in the presence or absence of the competitive inhibitor malonate:



42. In the absence of inhibitor the V_{max} is:

A) 1 umole/min
B) 2 umole/min
C) 3 umole/min
D) 4 umole/min
E) 6 umole/min

43. In the absence of inhibitor the K_m for fumarate is:

A) 1 millimolar
B) 3 millimolar
C) 6 millimolar
D) 10 millimolar
E) 18 millimolar

44. The effect of malonate:

A) Is to increase ΔG of the reaction
B) Is to decrease the V_{max} to 3 umole/min
C) Is to increase the K_m to 24 millimolar
D) Can be overcome by increasing the concentration of fumarate
E) Results in cooperative binding of fumarate

45. The level of protein structure that describes all aspects of the three-dimensional folding of a polypeptide is referred to as the

A) quaternary structure
B) secondary structure
C) tertiary structure
D) coiled structure
E) primary structure