BIOL/CHEM 3361   Name_____
Spring 2011
<div align="center">EXAM 2
FORM A</div>

Place your name at the top of this page of the exam. On the F-1712 Scantron form, use a no. 2 pencil to enter your test form designation, i.e., A or B. Also print and encode your name and your UTD ID (starting in the first column on the left and leaving the last spaces blank). Leave phone number, code and subject score sections blank.
Select the best answer for the following multiple-choice questions and enter the corresponding letter on the Scantron sheet. You may use these test pages to make notes and work problems.
You may use a non-graphing calculator or a graphing calculator you have cleared of all stored data.
When finished, turn in this exam along with your Scantron sheet.

1. The β turns of a protein are examples of
    a. primary structure
    b. secondary structure
    c. supersecondary structure
    d. tertiary structure
    e. quaternary structure

2. Which of the following is one of the six major classes of enzymes as designated by the International Union of Biochemistry?
    a. kinase
    b. aldolase
    c. lyase
    d. phosphatase
    e. recombinase

3. The T_m of a protein is
    a. the temperature at which it is catalytically most active
    b. the temperature at which the protein denatures
    c. the time it takes to undergo one round of catalysis
    d. the half-time for folding of the protein
    e. a type of turn the polypeptide can make, i.e. a secondary structure

4. Sulfa drugs are analogs of p-aminobenzoic acid (aka PABA). They function by
    a. competitively inhibiting folic acid synthesis
    b. uncompetitively inhibiting folic acid synthesis
    c. noncompetitively inhibiting folic acid synthesis
    d. irreversibly inhibiting folic acid synthesis
    e. none of the above

5. For a bisubstrate reaction, a Lineweaver-Burk plot consisting of a set of parallel lines is characteristic of
    a. a ping pong double displacement reaction.
    b. a random single displacement reaction.
    c. an ordered single displacement reaction
    d. a random triple displacement reaction
    e. none of the above.

6. Which of the following structures can form the basis of a protein domain?
   a. β-propellers
   b. β-sandwiches
   c. β-barrels
   d. a & c
   e. all of the above

7. When the [S]/K_m ratio is 4/1 for a Michaelis-type enzyme, what will be the v_o/V_{max} ratio?
   a. 1/9
   b. 2/3
   c. 1/1
   d. 4/5
   e. 1/4

8. Post-translationally modified amino acid residues in a protein are part of the protein's
   a. quaternary structure
   b. tertiary structure
   c. supersecondary structure
   d. secondary structure
   e. primary structure

9. Nerve gases and organophosphorus insecticides irreversibly inhibit
   a. cAMP phosphodiesterase
   b. cGMP phosphodiesterase
   c. acetyl cholinesterase
   d. D-alanyl transpeptidase
   e. aspartyl transaminase

10. Which of the following is a way enzymes catalyze reactions?
    a. lowering the Arrhenius activation energy
    b. forming better weak interactions with the transition state than with the substrate
    c. changing ΔG for the reaction
    d. a & b
    e. all of the above

11. For an enzyme that obeys Michaelis-Menten kinetics, what is the V_{max} value in μmoles/min if v = 35 μmoles/min when [S] = K_m ?
    a. 50 μmol/min
    b. 70 μmol/min
    c. 140 μmol/min
    d. 175 μmol/min
    e. 205 μmol/min

12. Which of the following enzymes is categorized as a hydrolase?
    a. trypsin
    b. glucokinase
    c. V8 protease
    d. a & c
    e. all of the above

13. Which of the following statements is true about competitive inhibition?
    a. V_{max} is unchanged
    b. K_m is unchanged
    c. V_{max} and K_m increase
    d. V_{max} and K_m decrease
    e. K_I is the same for E and ES

14. Lineweaver-Burk plots (aka. double reciprocal plots) can be used to
    a. determine K_m values
    b. distinguish between single and double displacement reaction mechanisms
    c. distinguish between competitive and noncompetitive inhibitors
    d. determine K_I if [I] is known
    e. all of the above

15. A measure of the specificity and efficiency of an enzyme is given by
    a. k_{cat}/K_m
    b. $k_{cat}[E]_{total}$
    c. k_1/k_{-1}
    d. $(k_{-1} + k_{cat})/k_1$
    e. the rate of catalysis at low [S]

16. The active sites of pepsin and the HIV protease contain
    a. two aspartate residues that have identical pKa values
    b. two aspartate residues that form a LBHB
    c. a serine that forms an unstable acylated intermediate
    d. an EHS catalytic triad
    e. a lysine that forms a Schiff base during catalysis

17. A β hairpin or meander is a type of
    a. sheet structure
    b. domain structure
    c. secondary structure
    d. super-secondary structure
    e. random coil

18. How many amino acids are there per repeat of an α-helix?
    a. 2
    b. 3
    c. 3.6
    d. 4.2
    e. 5

19. If the k_{cat} for a kinase is 10^4 sec^{-1} and it is present at 0.2 nM in a reaction, what will be V_{max} when [S] is saturating?
    a. 2.4 μM/sec
    b. 2.0 μM/sec
    c. 0.5 μM/sec
    d. 4.5 nM/sec
    e. 6.0 nM/sec

20. Consider the oligopeptide, THISISATEST, which forms an α-helix. Which of the following amino acid residues would you expect to be on the same side (face) of the α-helix as the initial threonine residue?
a. H at position 2
b. I at position 3
c. S at position 4
d. E at position 9
e. S at position 10

21. Consider the oligopeptide, THISISANEXAM, which forms one strand of a β-ribbon. Which of the following amino acid residues would you expect to be on the same side (face) of the β-ribbon as the asparagine residue? (X is the abbreviation for an unknown amino acid.)
a. H at position 2
b. I at position 3
c. X at position 10
d. a & b
e. a & c

22. If a carboxylase (Mr 40,000) at a concentration of 0.1 μg/ml and one active site per molecule has a V_{max} of 0.3×10^{-5} M/min, what will its turnover number be?
a. 1.2×10^2 /min
b. 1.2×10^3 /min
c. 2.1×10^3 /min
d. 4.8×10^3 /min
e. 5.1×10^4 /min

23. An enzyme has an apparent K_m of 2×10^{-3} M and a V_{max} of 1×10^{-4} moles/min. in the presence of 1×10^{-3} M competitive inhibitor ($K_I = 1 \times 10^{-7}$ M). What is the true K_m of the enzyme?
a. 2×10^{-7} M
b. 2×10^{-6} M
c. 2×10^{-5} M
d. 2×10^{-4} M
e. 2×10^{-3} M

24. The turnover number of an enzyme is also known as
a. k_{-1}
b. k_{cat}
c. k_{cat}/K_m
d. $(k_{-1} + k_{cat})/k_1$
e. K_m

25. General acid catalysis begins by
a. electrophilic attack by the conjugate base
b. withdrawal of OH^- from the substrate
c. addition of H^+ to the substrate
d. withdrawal of H^+ from the substrate
e. withdrawal of a hydrogen from the substrate

26. The φ angle refers to the amount of rotation about which bond(s) in the peptide backbone?
  a. N-C$_\alpha$
  b. C$_\alpha$-C$_{carbonyl}$
  c. C$_{carbonyl}$-N
  d. a & b
  e. a & c

27. Connections between strands of a β sheet
  a. are always β bends
  b. are always random coil
  c. are usually right handed
  d. are usually left handed
  e. none of the above

28. In classic noncompetitive inhibition
  a. the inhibitor can bind equally well to either the free enzyme or the ES complex
  b. the inhibitor binds to the ES complex better than to the free enzyme
  c. the inhibitor binds to the free enzyme better than to the ES complex
  d. the inhibitor can bind only to the free enzyme
  e. the inhibitor can bind only to the ES complex

29. Enzymes that are classified as oxidoreductases catalyze reactions in which
  a.   a there is a rearrangement of groups in a molecule
  b.   molecules exchange electrons
  c.   energy from ATP hydrolysis drives the reaction
  d.   there is an addition to a double bond without ATP hydrolysis
  e.   molecules exchange functional groups

30. What is the transition state geometry of the carbonyl carbon of a peptide bond during trypsin-catalyzed hydrolysis?
  a. trigonal
  b. pentagonal
  c. planar
  d. tetrahedral
  e. hexagonal

31. What type of plot is used to determine the number of ligand binding sites and dissociation constant for a ligand on a protein?
  a. van't Hoff
  b. Lineweaver-Burk
  c. Scatchard
  d. Michaelis
  e. Briggs-Haldane

32. Which of the following amino acids can serve as a general acid-base catalyst in an enzyme active site?
  a. asparagine
  b. histidine
  c. aspartic acid
  d. a & b
  e. b & c

33. To be activated, organophosporus insecticides such as malathion must
    a. be hydrolyzed
    b. be joined to glutamic acid
    c. be reduced
    d. have a phosphorus-bound sulfur replaced with oxygen
    e. have an acetyl group added to it

34. Enzymes with kinetics that produce an S-shaped (i.e., sigmodal) curve on a v_o vs. [S] plot are
    a. Michaelis-Menten enzymes
    b. Lineweaver-Burk enzymes
    c. perfect enzymes
    d. Scatchard enzymes
    e. allosteric enzymes

35. In leucine zipper proteins and fibrous α-keratin molecules found in hair, skin, cytoskeleton, etc. polypeptides associate via the formation of a
    a. left-handed coiled coil
    b. left-handed propeller
    c. greek-key cylinder
    d. barrel
    e. right–handed sandwich

36. Which of the following statements is true?
    a. Peptide bonds have a partially double-bond character.
    b. Peptide bonds can accept H^+ to become positively charged.
    c. Most peptide bonds in proteins have a cis configuration.
    d. a & c
    e. all of the above

37. Which of the following amino acid residues can participate in catalysis by formation of an unstable covalent intermediate?
    a. lys
    b. ser
    c. cys
    d. a & c
    e. all of the above

38. The cellular concentration of the substrate of an enzyme is often found to be
    a. approximately equal to its K_m value
    b. much less than its K_m value
    c. much greater than its K_m value
    d. equal to k_{cat}/K_m
    e. equal to k_{cat}

39. The collagen helix is a left-handed helix comprised of
    a. heptad repeats
    b. alternating polar and nonpolar amino acids
    c. gly-pro-x and gly-x-pro repeats
    d. 4.4 amino acids per repeat
    e. asp-gly-gly and glu-gly-gly repeats

40. What is the geometry of the groups that comprise a peptide bond?
    a. trigonal
    b. pentagonal
    c. planar
    d. tetrahedral
    e. hexagonal

41. Intrinsically unstructured proteins?
    a. adopt well-defined structures in complexes with their target proteins
    b. are characterized by an abundance of polar residues and a lack of hydrophobic residues
    c. are globular in shape
    d. a & b
    e. b & c

42. Which standard amino acid residue in proteins is often found in areas of a Ramachandran plot which are energetically unfavorable for L-amino acids?
    a. A
    b. G
    c. P
    d. T
    e. W

43. The Hsp60 proteins or chaperonins
    a. are prolyl isomerases
    b. template protein folding
    c. clamp down on polar residues in newly made proteins
    d. contain a catalytic triad comprised of His, Ser, and Pro
    e. form molecular vessels in which proteins can fold in isolation

44. Five noncompetitive inhibitors of an enzyme were found to exhibit the following K_I values. Which is the best inhibitor?
    a. $K_I = 1 \times 10^{-2}$ M
    b. $K_I = 3 \times 10^{-3}$ M
    c. $K_I = 3 \times 10^{-5}$ M
    d. $K_I = 7 \times 10^{-8}$ M
    e. $K_I = 5 \times 10^{-9}$ M

45. The Briggs and Haldane derivation of the generalized kinetic equation for a Michaelis-Menten enzyme differs from the original Michaelis-Menten derivation by the assumption that
    a. the product concentration is insignificant
    b the enzyme-substrate complex concentration does not change with time, i.e., it's in steady state
    c. the substrate concentration is large and does not change significantly with time
    d. the free enzyme concentration is always in great excess to the concentration of the enzyme-substrate complex
    e. the substrate-enzyme complex rapidly equilibrates with the free substrate and enzyme

46. (bonus) Penicillin is a
    a. noncompetitive inhibitor
    b suicide substrate
    c. lactam and contains a S atom
    d. a & c
    e. b & c

47. Define K_m mathematically in terms of the individual rate constants k_1, etc., and explain under what circumstance K_m approximates the dissociation constant for the substrate.

48. What is plotted on a Ramachandran plot and what two types of secondary structure correspond to the positions where most of the points cluster?

49. Draw the diagnostic Lineweaver-Burk plot for an enzyme in the presence and absence of an uncompetitive inhibitor. Label the axes and all intercepts, giving the values in terms of K_M, K_I, and [I] in the presence of the inhibitor.

Bonus question:
like Invirase, all four HIV protease inhibitors shown in your text have an oligopeptide-like backbone with a phenyl side chain attached near the center of the molecule and an -OH and -H on a nearby C of the backbone replacing the typical peptide bond carbonyl group. Give a reason for the phenyl group and another for the carbonyl replacement.
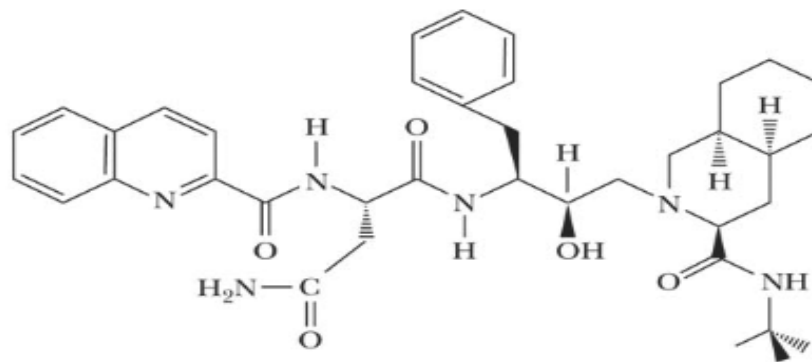
Invirase (saquinavir)

EXAM 2

Additional Questions for BIOL 6352 grad students (Answer on this page, sign above, and turn in with your Scantron sheet):

1. Formation of NACs is believed to be critical for enzyme catalysis. What does NAC stand for, and what are its two defining characteristics?

2. Write the formula for initial velocity of an enzyme-catalyzed reaction as a function of [S] as derived by Briggs and Haldane using the steady-state assumption. Explain how this formula is the basis for assay of enzyme concentration.

3. Metal ions (e.g., Zn^{2+}) chelated in the active sites of proteins can participate in catalysis by two different mechanisms. Name and describe these two mechanisms.