PART I ANSWER ONE ESSAY QUESTION FOR EACH PROFESSOR

Dr. Vukmirica's questions: Answer only one of the two following questions directly on this exam (each has 2 parts)

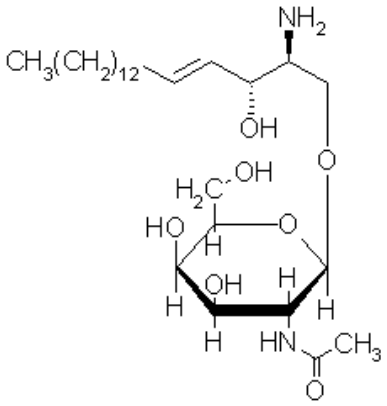
Vukmirica#1: A) What is the composition of a lipoprotein particle? What function do lipopoproteins serve? Briefly describe the exogenous and endogenous pathways of lipoprotein metabolism: Remember to give one example of a target tissue involved and at least one type of lipoprotein particle involved with each pathway.
B) Explain using an appropriate diagram the pathway of LDL receptor–mediated endocytosis.

DO NOT ANSWER THIS if you have already answered question Vukmirica#1

Vukmirica#2 A) Describe the mechanism of catalysis of a serine protease chymotrypsin. What is the difference between chymotrypsin and trypsin?
B) Identify three categories of reversible enzyme inhibition. Using Lineweaver-Burk plots show how these inhibitors can be distinguished by their kinetics of inhibition.

Dr. Mezl's questions: Answer only one of the two following questions

Mezl#1 Psychosine (on right) is obtained from bovine brain.
What type of compound is it?
Use the words that you have learned in Dr. Mezl's lectures to describe the structure in an unambiguous manner so that it could be drawn by one of your colleagues. Identify the sugar. Do not use one word to identify the upper chain: use nomenclature that describes the configurations, substituents and bond to the sugar. It is not important if you do not know the real name of the parent chain.
Use this figure to explain the anomer naming system.



DO NOT ANSWER THIS if you have already answered question Mezl#1

Mezl#2 Draw the RNA sequence ACT. Your diagram should show the charges, the configuration at each position of the first sugar and ALL the atoms and double bonds of all the bases. What is strange about this sequence? What is the complementary RNA sequence (Do not draw it)? Use your figure to explain the effect of base on DNA and RNA.

Dr. Bennett's questions: Answer only one of the two following questions

Bennett#1: In class and in the readings, we used the myosin V complex as an example of a protein that exhibited quaternary structure. Describe the structural features of myosin V. To answer this question, you may use a drawing to indicate the number and composition of the complex subunits, the relevant domains and secondary structural elements (i.e. α-helices, β-sheets, or turns), and the binding sites of the complex to both its cargo and actin.

DO NOT ANSWER THIS if you have already answered question Bennett#1

Bennett#2: We discussed in detail and in the readings how the myosin V complex undergoes a series of conformational changes that enables it to "walk" up actin filaments carrying a cargo. Describe this sequence of events.

PART II

Choose the **BEST** answer for each of the **multiple choice questions**
and fill it in on the computer answer sheet

1. A polypeptide with four peptide bonds is made up of how many amino acids?

A) 1 B) 2 C) 3 D) 4 E) 5

2. Which of the following bonds play a major role in stabilizing 3D protein structure but are not involved to any great extent in determining tertiary structure?

A) Disulfide bonding
B) Hydrophobic interactions
C) Dipole-dipole electrostatic forces
D) Hydrogen bonding
E) Ion-ion electrostatic forces

3. Secondary structural features of a protein are stabilized by which of the following interactions?

A) if **1,2, and 3** are correct
B) if **1 and 3** are correct
C) if **2 and 4** is correct
D) if **4** is correct
E) if **1,2,3, and 4** are correct

1) Salt bridges
2) Hydrophobic interactions
3) Disulfide bridges
4) Hydrogen bonds

4. Tertiary structure of a protein refers to:

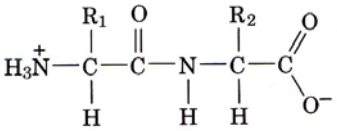
A) if **1,2, and 3** are correct
B) if **1 and 3** are correct
C) if **2 and 4** is correct
D) if **4** is correct
E) if **1,2,3, and 4** are correct

1) The three dimensional structure of a polypeptide taking into consideration its R-groups
2) The interactions involved in and required for protein folding
3) The native configuration that a protein normally assumes in its biological environment
4) The amino acid sequence specific to that protein

5. Which of the following exhibit a peptide bond?

A) if **1,2, and 3** are correct
B) if **1 and 3** are correct
C) if **2 and 4** is correct
D) if **4** is correct
E) if **1,2,3, and 4** are correct

1)



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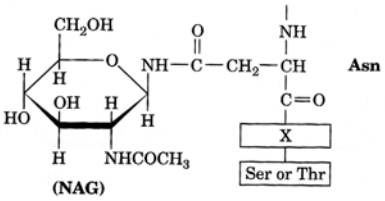

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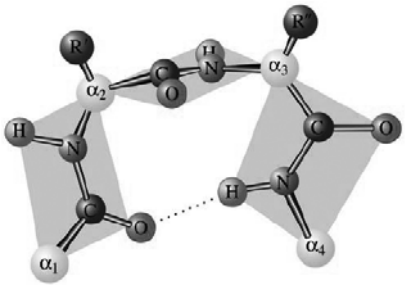
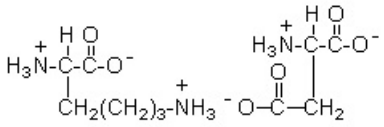


4)



6. The pitch of an α-helix is:

A) The rise per amino acid residue
B) The distance the helix rises along its axis in each turn
C) The number of peptides in each helical turn
D) A closed ring
E) A nonchiral ribbon

7. Which of the following statements are true:

A) if **1,2, and 3** are correct
B) if **1 and 3** are correct
C) if **2 and 4** is correct
D) if **4** is correct
E) if **1,2,3, and 4** are correct

1) The hydrophilic side chains of amino acid residues tend to locate themselves toward the exterior of globular proteins
2) Hydrogen bonds occur between atoms on amino acid R-groups and water molecules at the protein surface
3) Hydrogen bonds can form between backbone atoms and water
4) Hydrogen bonds cannot form between backbone atoms of two different amino acids

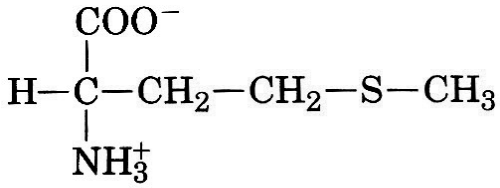
8. The net charge of Gly is positive in a solution with pH of:

A) 12 B) 9 C) 7 D) 6 E) 2

9. The isoelectric point for most amino acids that have non-polar side chains is approximately

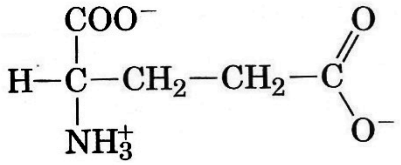
A) 12 B) 9 C) 7 D) 6 E) 2

10. This amino acid is:



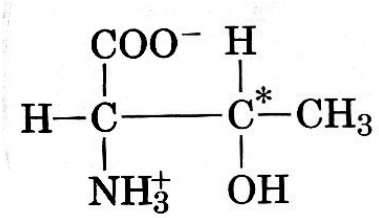
A) Methionine B) Cysteine C) Isoleucine D) Lysine E) Valine

11. This amino acid is:



A) D B) N C) Q D) E E) P

12. This amino acid is:



A) Thr B) Ser C) Tyr D) Phe E) Leu

13. Which of the following statements are true:

A) if **1,2, and 3** are correct
B) if **1 and 3** are correct
C) if **2 and 4** is correct
D) if **4** is correct
E) if **1,2,3, and 4** are correct

1) The specific sequence of amino acid residues in a protein is called its primary structure
2) A zwitterion is a molecule that has both a positive and negative charge at neutral pH
3) Arginine is the most basic of the 20 common amino acids
4) The sequence of a protein is given direction by indicating its primary structure from its C-terminus to its N-terminus

14. A histone is :

A) an acidic amino acid B) a basic amino acid C) a neutral amino acid
D) an acidic protein E) a basic protein

15. You see a picture of a 6 carbon pyranose called Testose in a textbook. To determine if it is D-testose or L-testose with CHIME, you will enter the structure into CHIME, ...

A) ask for the Van der Waals image and then turn the molecule.
B) and click on the icon "Configuration of reference carbon."
C) set to "Ball and Stick" and then turn the molecule.
D) and ask for "2D rendering".
E) This can not be done with Chime.

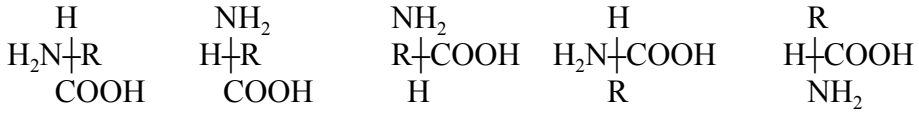
16. ..... have a biomass greater than that of mammals

A) Si-O bond based life forms that live in the ground
B) Si-O bond based life forms that live at the bottom of oceans
C) Si-Si bond based life forms that live in the ground
D) Si-Si bond based life forms that live at the bottom of oceans
E) Chemolithotrophs living in the ground

17. You add 0.01 ml of 1 mM HCl to 1 L of water. The pH will be about:

A) 3 B) 6 C) 6.5 D) 7 E) 8

18. Which of the following depicts an L-amino acid?



(A) (B) (C) (D) (E)

19. In a normal individual glucose is ..... % of blood.

A) 0.5 % B) 0.1 % C) 0.05 % D) 0.01 % E) 0.005 %

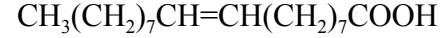
20. Lipids are the biomolecules of choice for storage of metabolic energy because they:

A) can be stored in anhydrous form
B) are highly oxidized relative to carbohydrates and proteins
C) are amphipathic
D) are easily hydrolysed
E) A and B are both correct

21. Which of these statements about the composition of biological membranes is **false**?

A) free fatty acids are not found as components of biological membranes
B) cholesterol increases membrane fluidity
C) biological membrane is composed of integral and peripheral proteins
D) transmembrane proteins of the membrane completely span the membrane
E) phosphatidylcholine is the constituent of biological membranes

22. The chemical formula to the right represents:



A) lauric acid
B) palmitic acid
C) oleic acid
D) linoleic acid
E) arachidonic acid

23. If a phospholipid molecule contains $-CH_2CH_2N(CH_3)_3$ group attached to a phosphoryl group this is:

A) phosphatidic acid
B) phosphatidylglycerol
C) phosphatidylinositol
D) phosphatidylcholine
E) sphingomyelin

24. Cholesterol is **NOT**:

A) an alcohol
B) a major constituent of membranes
C) esterified to yield a molecule which is more hydrophilic
D) a major constituent of chylomicron remnants
E) a precursor for testosterone

25. Which one of these molecules is **NOT** a glycosphingolipid?

A) cerebroside B) sulfatide C) globoside
D) sphingosine E) ganglioside

26. Niemann-Pick disease is due to an enzyme defect with:

A) fatty acid synthesis
B) cholesterol synthesis
C) sphingomyelin synthesis
D) glucose transport
E) vitamin degradation

27. Inside intestinal cells, fatty acids form complexes with:

A) LDL receptor
B) albumin
C) hormone-sensitive lipase
D) glucose transporter
E) fatty-acid binding protein

28. H^+ ions move across the membrane and the energy generated is used to power the transport in opposite direction of another substance (sucrose). This is an example of:

A) exocytosis
B) endocytosis
C) facilitative diffusion
D) antiport
E) symport

29. Pinocytosis describes a process where:

A) bacteria are engulfed by cells
B) cells are drinking
C) specific receptors are required
D) large molecules like cholesterol are internalized
E) large molecules are exported out of the cell

30. Apolipoprotein A-I activates:

A) LDL receptor
B) lipoprotein lipase (LPL)
C) chylomicron receptor
D) lecithin cholesterol acyl transferase (LCAT)
E) VLDL

31. What statement is **NOT** true regarding Tangier disease?

A) Tangier disease is due to a mutation of the ABC1 transporter gene
B) Tangier disease leads to premature coronary artery disease
C) Tangier disease is associated with intracellular cholesterol accumulation
D) Tangier disease is associated with increased plasma HDL levels
E) Tangier disease symptoms include orange-coloured tonsils

32. Chemical name for vitamin E is:

A) retinol B) cholecalciferol C) ergocalciferol
D) phylloquinone E) tocopherol

33. The following statements are correct about the diseases caused by vitamin deficiencies **except**:

A) vitamin A deficiency leads to night blindness
B) vitamin B_{12} deficiency can lead to anemia
C) thiamin deficiency leads to pellagra
D) vitamin D deficiency leads to rickets
E) ascorbic acid deficiency leads to scurvy

34. The Michaelis-Menton equation is:

A) v = (Vmax [S])/ Km + [S])
B) v = (Km [S])/ Vmax
C) v = (Km [S])/ Vmax + [S])
D) v = (Km + [S])/ Vmax [S])
E) v = (Vmax +[S])/ Km [S])

35. A small Km value (less than 10^{-3} M) signifies:

A) low affinity of the enzyme for its substrate
B) maximal catalytic efficiency is achieved at high substrate concentrations
C) maximal catalytic efficiency is achieved at low substrate concentrations
D) the reaction is not affected by temperature
E) the reaction is zero order

36. Using a Linewear-Burk plot, the x-intercept gives:

A) Km B) 1/Vmax C) Vmax
D) Km/Vmax E) -1/Km

37. Liver alcohol dehydrogenase uses which of the following mechanisms of catalysis?

A) acid-base catalysis B) catalysis by proximity C) covalent catalysis
D) electrostatic catalysis E) metal ion catalysis

38. Cyanide is an example of:

A) irreversible enzyme inhibitor
B) competitive enzyme inhibitor
C) non-competitive enzyme inhibitor
D) uncompetitive enzyme inhibitor
E) a coenzyme

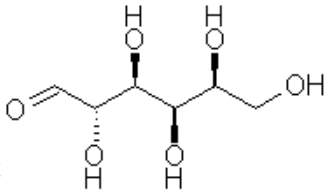
39. Which of the following statements is **false**?

A) trypsinogen is a zymogen
B) trypsinogen is synthesized in the pancreas
C) trypsinogen is activated by cleavage of peptide bonds
D) trypsinogen is an active enzyme
E) trypsin is a serine protease

40. A hemi acetal is

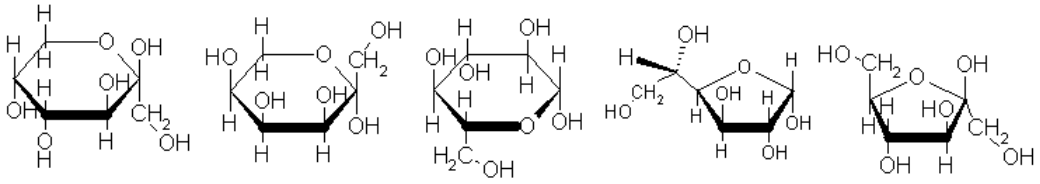
A) more reduced than an aldehyde
B) more oxidized than an aldehyde
C) a molecule that contains an aldehyde group linked to an alcohol group
D) a molecule that contains an aldehyde group linked to two alcohol groups
E) a hidden ketone

41. The molecule on the right is:



A) D-glucose
B) L-mannose
C) D-galactose
D) An L-sugar but not one of the ones to know by heart
E) A D-sugar but not one of the ones to know by heart

Use the structures below as answers for the following questions



[I] [II] [III] [IV] [V]

42. ..... are aldoses

A) [I], [II], [III] B) [III], [IV] C) [IV], [V] D) [II], [IV] E) [I], [V]

43. A lactone :

A) [I], [II] B) [I], [II] , [IV] C) [III] D) [IV]
E) is not among these structures

44. A deoxy sugar :

A) [I], [II] B) [I], [II] , [IV] C) [III] D) [IV]
E) is not among these structures

45. ..... have the L-configuration

A) [I], [II], [III] B) [III] , [IV] C) [IV] , [V] D) [II] , [IV] E) [I] , [V]

46. Glucose is structure :

A) [I] B) [II] C) [III] D) [IV] E) [V]

******** END OF QUESTIONS ON STRUCTURES **********

47. A .... makes a phosphodiester bond between two nucleotides.

A) oxidation B) reduction C) hydrolysis D) dehydration E) tautomerization

48. In a purine nucleotide, the bond between the base and sugar is a ..... bond.

A) C-C B) C-N C) C-O D) N-O E) P-O

49. Which is the biggest molecule among the following?

A) Cytosine B) Guanosine C) Adenine D) Thymine E) Uracil

50. If one compares two solutions containing equal weights, guanine will absorb ..... light at 260 nm than guanosine and if one compares solutions containing equal moles, guanine will absorb ..... than guanosine.

A) more; the same amount B) the same amount ; less C) more; less
D) less; the same amount E) They will not absorb light at 260 nm

51. A sample contains DNA and RNA. It is treated with a base (NaOH for example). The result is:

A) The sample now contains only DNA.
B) The sample now contains only RNA.
C) The base hydrolysed the DNA and the RNA.
D) The RNA precipitates and the DNA stays in solution.
E) The DNA precipitates and the RNA stays in solution.

52. The amount of DNA in your average chromosome is about ..... base pairs.

A) $900\ 10^6$ B) $150\ 10^6$ C) $7\ 10^6$ D) $0.7\ 10^6$ E) $0.12\ 10^6$

53. If one compared the B structure of DNA with the Z structure (for the same number of nucleotides), the B structure would be

A) wider and shorter B) the same width and shorter
C) narrower and shorter D) wider and longer
E) narrower and longer

54. The complementary strand to AGCT is :

A) AGCT B) TCGA C) CTAG D) GATC E) CTGA

55. A gene is expressed in brain but not in liver. You examine this sequence on gels. The normal result should be :

	Southern gel		Northern gel	
	brain	liver	brain	liver
A)	one band	the same band	one band	the same band
B)	one band	the same band	one band	no band
C)	one band	no band	one band	no band
D)	one band	a different band	one band	no band
E)	one band	a different band	one band	a different band

56. 1L of a 50mM weak acid (pK = 7) was adjusted to pH 7. If you add 10 milliequivalents of base, the pH will be :

A) 7.2 B) 7.4 C) 7.6 D) 7.8 E) 8

57. In pure water, about ..... water molecules are ionized.

A) 0.01% of the B) one in 10^6 C) one in 10^9 D) one in 10^{12} E) one in 10^{14}

XXXXXXXXXXX **PART III LAB EXAM** **XXXXXXXXXXXXXX**

Students in BCH2333 continue answering on the same computer answer sheet

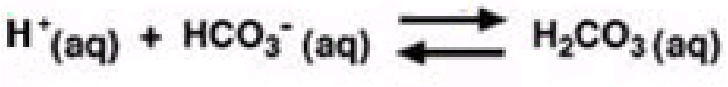
*STUDENTS REGISTERED FOR **BCH2140** DO NOT DO THIS PART*

The first five questions cover the Tutorials

58. It's your first day as an Honours student and you are asked to prepare a 2 M Tris solution and a 0.7 M EDTA solution (MW Tris: 121.14 g/mol; MW EDTA: 372.24 g/mol). Once you have made these solutions, you are asked to prepare 40 ml of a TE solution (40 mM Tris, 0.5 mM EDTA). How much 2 M Tris solution, 0.7 M EDTA solution and water would you mix in order to make the desired TE solution?

a. 0.8 ml Tris, 29 ul EDTA, 39.171 ml water
b. 800 ul Tris, 29 ml EDTA, 10.2 ml water
c. 0.76 ml Tris, 25 ul EDTA, 39.175 ml water
d. 760 ul Tris, 25 ml EDTA, 14.24 ml water
e. There is not enough information in the question to find the answer

59. The most important buffer system found in the blood is the bicarbonate/carbonic acid system. The p*K*a for that buffer system is 6.1 and the total amount of bicarbonate and carbonic acid in the blood can be estimated to 50 mmoles. What's the carbonic acid/bicarbonate ratio at normal blood pH, i.e. more or less 7.2?



a. The carbonic acid/bicarbonate ratio is about 0.08
b. The carbonic acid/bicarbonate ratio is about 0.04
c. The carbonic acid/bicarbonate ratio is about 12.5
d. The carbonic acid/bicarbonate ratio is about 25
e. The carbonic acid/bicarbonate ratio is about 37.5

60. You want to develop an antibody specific to protein X. You inject a rabbit with protein X, wait for an appropriate period of time, and then collect the rabbit's blood. You then use centrifugation to obtain the serum fraction. Which technique would you use to isolate the protein X antibody from the serum for use in subsequent experiments?

a. Thin Layer Chromatography (TLC)
b. Hydrophobic Chromatography
c. Affinity Chromatography
d. Frontal Electrophoresis
e. Western blotting

61. When centrifugation is applied, which of the following would pellet out at the lowest gravitational force?

a. Ribosomes
b. Soluble Proteins
c. Mitochondria
d. Cellular Nuclei
e. The above cannot be distinguished using centrifugation

62. Which of the following types of emission travels the farthest in air?

a. Alpha
b. Beta
c. Gamma

The last five questions cover Lab Protocols

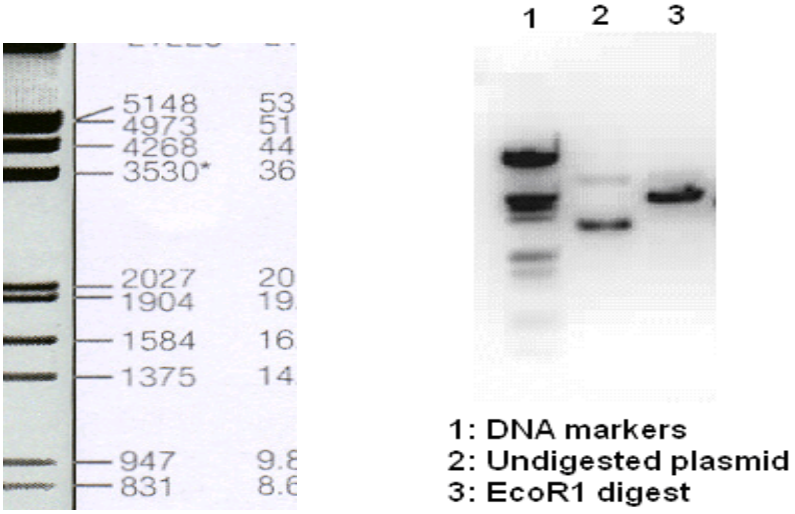
63. LAB 1: Gel filtration chromatography is used to resolve a mixture of starch, sucrose and glucose. Choose THE best answer.

a. The first molecule to be eluted out of the column is glucose
b. The void volume could be estimated as the elution volume of starch
c. The distribution coefficient for glucose is higher than the one for starch
d. A and b are true
e. B and C are true

64. LAB 2: A 10X dilution of a membrane suspension obtained by differential centrifugation gives an absorbance value of 0.1 at 280nm. What's the protein amount present in your undiluted membrane suspension assuming that its volume is 1ml? Assume that the extinction coefficient at 280nm is 1 $M^{-1}cm^{-1}$.

a. 0.1 micromole
b. 1 gram
c. 1 millimole
d. 1 milligram
e. Impossible to calculate that information based on the information provided

65. LAB 3: A restriction digest was performed to assess for the presence of an EcoR1 restriction site within a working plasmid. The figure at the left indicates the size in bps and weight in ngs for each of the DNA markers. What's the size of the plasmid under investigation?



a. About 7,000 bps
b. About 5,000 bps
c. About 2,800 bps
d. About about 12,000 bps

66. LAB 4: You want to resolve a mixture of three amino acids, glutamate, alanine and arginine, by ANION exchange chromatography. A phosphate buffer (10mM) at pH 6.0 is used as the eluent phase. What's the expected elution sequence?

a. Glutamate (first), alanine, and arginine (last)
b. Arginine (first), alanine, glutamate (last)
c. Alanine (first), arginine, glutamate (last)
d. Glutamate (first), arginine, alanine (last)

67. LAB 5: An enzyme assay was performed to assess the reaction velocity at different substrate concentrations. The results are provided in the table below. Choose THE best statement relative to the interpretation of those results.

Substrate concentration (mmol/ml)	Reaction velocity (umol/min)
1	1
2	3
3	5
4	6.5
5	7
6	7.3
10	7.5

a. The Km value for those experimental conditions is about 3.2 mmol/ml
b. Most enzyme molecules are saturated with a substrate molecule for substrate concentrations above 10 mmol/ml
c. The addition of a competitive inhibitor would increase the Km value
d. a and b are true
e. b and c are true