

THE UNIVERSITY OF MANITOBA

Tues October 28, 1997

Midterm EXAMINATION

Paper NO: _____

PAGE NO.: 1 of 7

TIME: 2 HOURS

DEPARTMENT & COURSE NUMBER: Chemistry 2.277 & Microbiology 60.277

EXAMINATION: Elements of Biochemistry

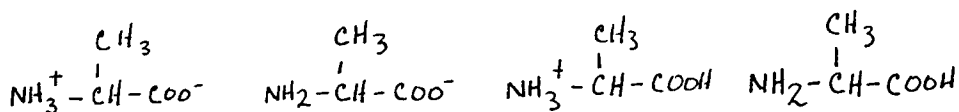
EXAMINERS: Drs. F. Hruska & A. Scott

GENERAL INSTRUCTIONS

1. You must mark the answer sheet with pencil (not pen).
2. Put your name and enter your student number on the answer sheet.
3. The examination consists of multiple choice questions. Choose what you think is the best, correct answer and record your choice on the answer sheet. There is only **ONE CORRECT** answer.
4. This exam will count for 25% of your final mark.

MULTIPLE CHOICE QUESTIONS

1. Because a segment of the morphine molecule resembles ?, it is able to bind to receptors in the brain which normally bind pentapeptides like Met-enkephalin, a natural pain killer.
A) cysteine B) glutamate C) histidine D) isoleucine E) tyrosine
2. ? has a methyl group in its side chain.
A) arginine B) glutamine C) leucine D) lysine E) serine
3. ? does NOT contain sulfur or oxygen atoms in its R group.
A) glutamine B) methionine C) tryptophan D) tyrosine E) threonine
4. ? has two ring systems in its structure (bicyclic).
A) histidine B) proline C) phenylalanine D) tyrosine E) tryptophan
5. An unusual amino acid with 3 chiral carbon atoms was isolated from a microorganism. Its molecule has ? possible stereoisomeric forms.
A) 3 B) 6 C) 8 D) 9 E) 27
6. Solution X has pH = 7.0. The [H⁺] in solution Y is 100,000 larger than that in solution X. The pH of solution Y is ?.
A) 1.0 B) 2.0 C) 5.0 D) 12.0 E) 13.0
7. 50 mL of 0.1 M NaOH are added to 150 mL of 0.2 M acetic acid. K_a (lactic acid) = 1.9×10^{-5} . The resulting solution has a pH which is closest to ?.
A) 3.5 B) 4.0 C) 4.5 D) 5.0 E) 5.5
8. The conjugate base of the cationic form of alanine is ?. A. None of B-E
B C D E



9. The isoelectric pH (pI) of glycine is 6.0. In a solution at pH 4, which form of glycine has the SECOND highest concentration?
A) cationic B) zwitterionic C) anionic D) the form with no charged groups.

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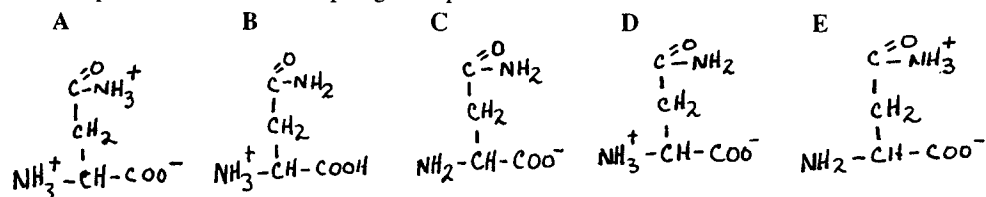
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10. The predominant form of asparagine at pH 7 is:



11. The amino acid ? has the chemical formula $\text{C}_5\text{H}_9\text{O}_2\text{N}$ at pH 7.

- A) alanine B) isoleucine C) leucine D) proline E) valine

12. We have 10 mL of a 0.1 M phenylalanine solution at pH 9.13. How many mL of 0.2 M HCl must be added to this solution to make the pH equal to the pI for Phe? The pKa values for Phe are 1.83 and 9.13.

- A) 0.5 B) 1.5 C) 2.5 D) 3.5 E) 4.5

13. True (A) or False (B): An oligopeptide with 10 amino acid residues has 10 peptide bonds.

14. ? different dipeptides can be made from alanine, glycine and valine.

- A) 3 B) 5 C) 6 D) 8 E) 9

15. The molecular weight of a dipeptide with an alanine residue and a serine residue is ? g at pH 7. (Atomic weights in grams: H = 1; C = 12; N = 14; O = 16; S = 32)

- A) 168 B) 170 C) 172 D) 174 E) 176

16. Which one of the following tetrapeptides has a zero net charge at pH 7?

- A) gly-thr-ser-glu B) lys-val-ala-arg C) lys-ile-phe-gln D) arg-ser-leu-asp
E) trp-pro-asp-gly

17. Statement(s) ? about the insulin molecule are true.

- 1) The active insulin molecule has a total of 4 polypeptide chains (a pair of α chains and a pair of β chains) which are held together by noncovalent bonds only.
 - 2) The molecule has only intramolecular S-S bridges.
 - 3) Insulins obtained from animal sources (e.g. pig) have been used to treat human diabetics.
 - 4) The sequence of insulin was determined by Watson and Crick.
 - 5) The chains of insulin have identical primary (1°) structures.
- A) only 3 B) only 5 C) 1 and 3 D) 2 and 4 E) 2 and 5.

18. ? is a correct statement about the naturally occurring α -helix.

- A) The plane of the peptide group is essentially perpendicular to the helix axis.
B) It is found only in globular proteins. C) It has a left-handed twist.
D) It is particularly stable in segments composed entirely of glycine.
E) The C=O group of residue 1 of the helix is hydrogen bonded to an N-H of residue 5 in the helix.

19. True (A) or False (B): Silk is composed mainly of proteins with an α -helical conformation.

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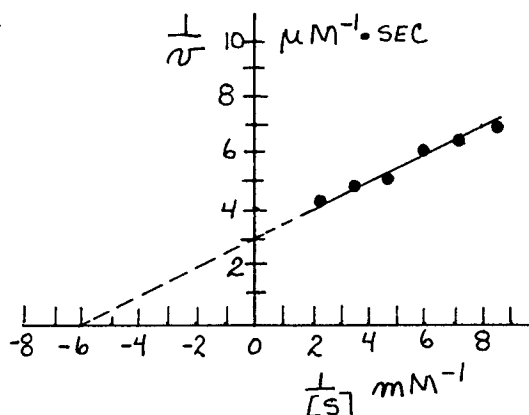
20. Which of the following statements about hemoglobin (Hb) is true?
 A) Hb is a good example of a "simple protein".
 B) People afflicted with "sickle-cell anemia" have HbS, a variant of normal hemoglobin.
 C) Since Hb is a globular protein, we may conclude that only a small fraction of its amino acid residues (<50%) exists in α -helical regions.
 D) Hemoglobin is said to have quaternary structure because it consists of several polypeptide chains held by S-S bonds.
 E) None of A-D is True.
21. The statements ? & ? about myoglobin (Mb) and lysozyme are correct.
 1) Both have only one polypeptide chain. 2) Both have S-S bridges. 3) In both, the number of amino acid residues in α -helical segments exceeds the number in β -sheets. 4) Both are globular proteins. 5) Both require an organic prosthetic group for activity.
 A) 1 & 2 B) 1 & 4 C) 2 & 3 D) 2 & 5 E) 3 & 4
22. Statement ? about enzymes is true.
 A) The optimum pH of pepsin, the stomach enzyme, is around 7.4.
 B) Carboxypeptidase A cleaves dietary proteins near their amino terminus.
 C) The protein-digesting enzyme trypsin is converted to its active zymogen form in the intestine.
 D) The metalloenzyme carboxypeptidase A requires a bound iron ion for activity.
 E) Penicillin inhibits "transpeptidase" by forming a covalent bond with it.
23. The correct statement about the K_m for a reaction catalyzed by an enzyme that shows a hyperbolic v versus $[S]$ curve is ?.
 A) If two substrates can bind to the same active site, the substrate with the smallest K_m is the more strongly bound.
 B) The enzyme active sites are saturated with substrate when the substrate concentration is equal to the K_m .
 C) It is called the Lineweaver-Burk constant.
 D) The rate of the reaction is equal to the product of K_m and V_{max} .
 E) Enzyme saturation occurs when $K_m = V_{max}$.

Use the kinetic data plotted in the accompanying graph to answer Questions 24, 25, & 26.

24. The magnitude of V_{max} is about ? $\mu M \cdot sec^{-1}$.
 A) 0.33 B) 0.67 C) 2.0 D) 3.0 E) 7.0

25. The magnitude of K_m is ? mM.
 A) -6.0 B) -0.17 C) 0.17 D) 3.5 E) 6.0

26. The largest substrate concentration used in the kinetic study was about ? mM.
 A) 0.12 B) 0.45 C) 2.2 D) 4.2 E) 8.5



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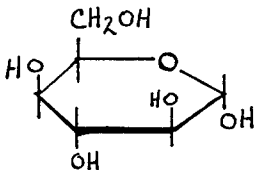
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27. Which of the following statements about allosteric enzymes are correct?
 1) They usually have only one active site. 2) Both substrate and allosteric inhibitor bind at the active site. 3) They are oligomeric proteins. 4) They show "cooperative substrate binding". 5) They usually show hyperbolic plots v versus $[S]$ plots with a large V_{max} .
- A) 1 & 2 B) 2 & 3 C) 3 & 4 D) 4 & 5 E) 3 & 5.
28. When the linear form of D-galactose cyclizes to form a ring, the ring product may be called:
 A) a sugar alcohol B) a galactoside C) an ester D) a hemiacetal
 E) None of A-D is correct.
29. A ketohexose in its ring form has ? chiral carbon atoms.
 A) 1 B) 2 C) 3 D) 4 E) 5
30. True (A) or False (B): Classification of aldoses is based on the configuration of the chiral carbon closest to aldehyde carbon.
31. Which of the following is an anomeric pair?
 A) D-glucose and L-glucose. B) D-glucose and D-fructose
 C) α -D-galactopyranose and β -D-galactopyranose. D) D-glucose and L-fructose
 E) D-dihydroxyacetone and L-dihydroxyacetone
32. The structure shown is that of ?.
 A) α -D-glucopyranose B) β -D-glucopyranose
 C) α -D-galactopyranose D) β -D-galactopyranose
 E) none of the above
- 
33. An aqueous solution of ? will show mutarotation.
 A) methyl- β -D-glucopyranoside B) D-glyceraldehyde C) sucrose
 D) Dihydroxyacetone E) none of the above
34. True (A) or False (B): A 1 M solution of maltose will produce the same amount of Cu_2O as a 1 M solution of glucose, when the solutions are treated with an excess of Benedict's solution.
35. Which of these statements about lactose is correct?
 A) It is a non-reducing sugar. B) It is an epimer of cellobiose.
 C) The two units are joined by an α 1 α 4 glycosidic bond.
 D) One of the units is an aldose, the other is a ketose. E) All of these statements are false.
36. Given the atomic weights (H= 1; C = 12; O = 16), calculate the molecular weight of sucrose.
 A) 300 B) 342 C) 351 D) 360 E) 375

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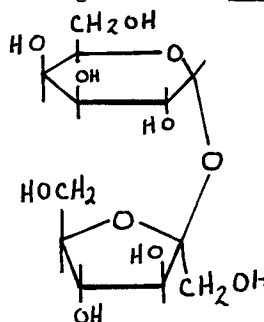
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37. Consider the disaccharide below. Which of the following statements is false?

- A) Its common name is sucrose.
- B) It is a non-reducing sugar.
- C) It contains two hexose sugars.
- D) The two units are joined by an α 1 β 2 glycosidic bond.
- E) One unit is an aldose, the other is a ketose.



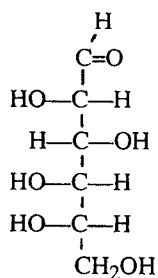
38. Which one of the following pairs of disaccharides will be formed in the incomplete hydrolysis of glycogen?

- A) lactose & isolactose
- B) mannose & isomannose
- C) maltose & isomaltose
- D) sucrose & maltose
- E) maltose & isomannose

39. The types of glycosidic bonds linking glucose units in starch are

- A) α -1,4 only
- B) β -1,4 only
- C) α -1,4 and α -1,6
- D) α -1,4 and β -1,6
- E) β -1,4 and α -1,6

40. True (A) or False (B): The molecule whose structure is shown below is a component of natural sucrose.



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LAB SECTION (Questions 41 to 50)

41. A buffer solution is prepared by mixing 500 mL of 0.4 M sodium acetate and 500 mL of 0.2 M acetic acid. What is the pH of the buffer solution prepared? (pKa for acetic acid = 4.76)
- A) 5.46 B) 5.06 C) 4.76 D) 4.46 E) 4.06
42. If 100 mL of 0.5 M HCL is added to the buffer prepared above in question 41. What is the pH of the final solution?
- A) 4.16 B) 4.63 C) 4.76 D) 4.88 E) 5.36

For Questions 43 and 44, please refer to the following: Paper chromatography with a solvent containing ethanol: ammonia: water (8:1:1) was used to separate three amino acids, glutamic acid (Glu), phenylalanine (Phe), and serine (Ser).

43. Which of the amino acids would be found closest to the origin?
- A) Glu B) Phe C) Ser D) Glu and Ser equally close
E) cannot be determined
44. Which amino acid would have an Rf closest to 1.0?
- A) Glu B) Phe C) Ser D) Glu and Ser equal and closest
E) cannot be determined

For Questions 45 and 46, please refer to the following: A solution of 1×10^{-5} M Na_2ATP has an absorbance of 0.155 at 260 nm in a 1 cm sample holder.

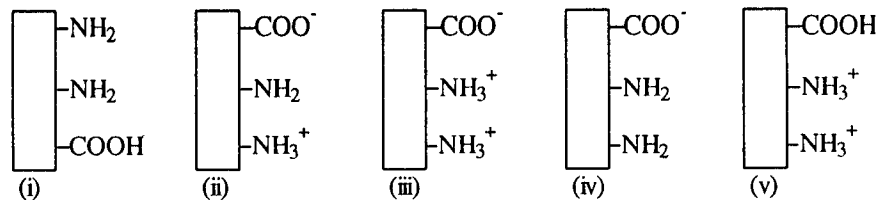
45. What is the value of E, the molar extinction coefficient?
- A) 6.45×10^{-5} litre $\text{mol}^{-1} \text{cm}^{-1}$
B) 1.60×10^{-6} litre $\text{mol}^{-1} \text{cm}^{-1}$
C) 1.55×10^4 litre $\text{mol}^{-1} \text{cm}^{-1}$
D) 1.68×10^3 litre $\text{mol}^{-1} \text{cm}^{-1}$
E) Cannot be determined
46. What would be the absorbance for a solution with a concentration of 1.4×10^{-5} M?
- A) 0.326 B) 0.217 C) 9.032 D) 0.110 E) Cannot be determined

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47. Which of the following would result in a 1 in 50 dilution of an original solution Y.
- A) A 5 mL aliquot of Y was diluted with 20 mL of buffer. This was further diluted by taking a 2 mL aliquot and adding 18 mL buffer.
- B) A 10 mL aliquot of Y was diluted by adding 40 mL of buffer.
- C) A 0.5 mL aliquot of Y was diluted with 9.5 mL of buffer. This was further diluted by taking a 0.3 mL aliquot and adding 8.7 mL buffer.
- D) All of the above.
- E) None of the above.

For questions 48, 49 and 50 please refer to the following:

Lysine can be schematically represented in the following way:



The pka values for lysine are 2.2, 8.9 and 10.9.

48. Which species would exist at pH 11.9
- A) v B) iii C) i D) iv E) iii
49. Which species would not exist in solution
- A) i B) ii C) iii D) iv E) v
50. Which species would exist at pH 8.9
- A) iii & v B) ii & iii C) ii D) ii & iv E) iii

Answers for 2.277/60.277 Exams 96/97, 97/98 and 98/99

Question Number	277 Midterm			277 Final		
	96/97	97/98	98/99	96/97	97/98	98/99
1.	B	E	D	D	E	D
2.	B	C	B	B	E	E
3.	C	C	A	B	A	A
4.	F	E	A	D	C	B
5.	A	C	C	B	B	D
6.	G	B	B	C	E	D
7.	G	B	B	A	D	A
8.	C	B	B	E	A	B
9.	D	A	C	B	B	D
10.	B	D	D	A	B	E
11.	F	D	A	F	A	A
12.	C	C	B	A	B	C
13.	B	B	B	A	C	A
14.	H	E	A	D	D	E
15.	D	E	A	D	B	C
16.	D	D	C	D	C	A
17.	F	A	A	C	A	E
18.	E	E	A	A	E	D
19.	B	B	D	E	A	C
20.	B	E	E	A	D	C
21.	F	B	B	C	D	D
22.	C	E	D	B	D	C
23.	A	A	A	D	C	C
24.	B	A	E	A	E	A
25.	A	C	B	C	E	E

Continued....

Question Number	277 Midterm			277 Final		
	96/97	97/98	98/99	96/97	97/98	98/99
26.	C	B	A	C	A	B
27.	D	C	A	B	C	E
28.	E	D	A	E	E	A
29.	D	D	A	B	C	C
30.	B	B	C	C	A	B
31.	D	C	A	E	C	B
32.	E	E	B	E	E	E
33.	B	E	B	A	B	A
34.	B	A	A	B	E	B
35.	E	B	B	C	D	D
36.	D	B	B	D	A	E
37.	E	A	A	C	A	B
38.	A	C	A	E	B	C
39.	C	C	C	C	E	B
40.	C	B	B	D	B	A
41.	B	B	A	A	D	D
42.	A	C	C	E	B	C
43.	B	A	B	D	E	B
44.	D	B	C	D	A	B
45.	C	C	E	C	A	B
46.	B	B	A	A	B	E
47.	D	A	D	E	E	D
48.	D	D	B	A	C	B
49.	C	A	E	B	A	A
50.	A	B	E	B	B	E