

THE UNIVERSITY OF MANITOBA

Tues October 29, 1996

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

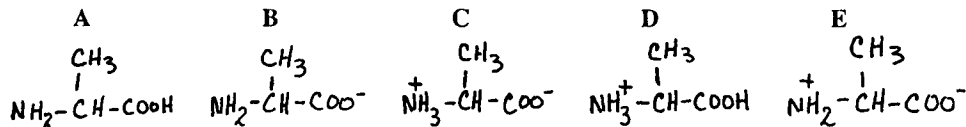
EXAMINERS: Drs. F. Hruska & A. Scoot

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 the answer that you think is correct 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. Which of the following amino acids has a hydroxyl group in the side chain?
A) histidine B) tyrosine C) asparagine D) isoleucine E) None has a hydroxyl group.
2. Which of these amino acids does not have 2 or more methylene (CH₂) groups in its side chain?
A) arginine B) leucine C) lysine D) methionine E) proline
3. The R group -CH₂C₆H₅ belongs to which amino acid?
A) tryptophan B) proline C) phenylalanine D) histidine E) methionine
4. Which one of the following amino acids has two chiral carbon atoms?
A) serine B) tryptophan C) aspartate D) leucine E) proline
F) none of these have two chiral atoms
5. If an aqueous solution of D-alanine (2 g/mL) rotates the plane of plane polarized light by +3.6°, an aqueous solution of L-alanine (3 g/mL) will rotate the plane by:
A) -5.4° B) -3.6° C) -1.8° D) 0.0° E) +1.8° F) +3.6° G) +5.4°
6. If the pH of human saliva is 6.4, and the pH of lemon juice is 2.4, the [H⁺] in the lemon juice is ? times as large as the [H⁺] in saliva.
a) 0.001 B) 0.38 C) 0.60 D) 2.67 E) 4 F) 2,600 G) 10,000
7. 10 mL ^{OF} 0.1 M NaOH are added to 6 mL of 0.2 M lactic acid. K_a of lactic acid is 7.94 x 10⁻⁵. The resulting solution has a pH which is closest to:
A) 7.9 B) 7.3 C) 6.8 D) 6.3 E) 5.8 F) 5.3 G) 4.8
8. In aqueous solution, the conjugate acid of the anionic form of alanine is



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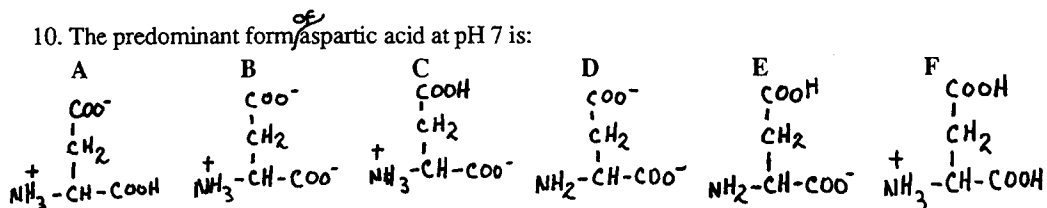
EXAMINATION: Elements of Biochemistry

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9. You wish to make a solution that is buffered at pH 5. On the shelf of chemicals in the lab you see five bottles, each containing a different acid—acid1, acid2, acid3, acid4 and acid5—which have K_a values 3×10^{-2} , 5×10^{-3} , 9×10^{-4} , 9×10^{-6} , and 1×10^{-7} , respectively. Which acid would you select in your preparation of the solution that would give the best buffering action at pH5?

- A) acid1 B) acid2 C) acid3 D) acid4 E) acid5

10. The predominant form of aspartic acid at pH 7 is:



11. The chemical formula for the zwitterionic form of threonine is

- A) $\text{C}_3\text{H}_6\text{O}_3\text{N}$ B) $\text{C}_3\text{H}_7\text{O}_3\text{N}$ C) $\text{C}_4\text{H}_7\text{O}_3\text{N}$ D) $\text{C}_4\text{H}_8\text{O}_3\text{N}$
E) $\text{C}_4\text{H}_9\text{O}_2\text{N}$ F) $\text{C}_4\text{H}_9\text{O}_3\text{N}$

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 pK_a values for Phe are 1.83 and 9.13.

- A) 0.5 B) 1.5 C) 2.5 D) 3.5 E) 4.5 F) 5.5

13. True (A) or False (B): A pentapeptide has 5 peptide bonds.

14. If a biochemistry laboratory has a total of 8 different α -amino acids, how many different dipeptides could be made?

- A) 8 B) 16 C) 24 D) 32 E) 40 F) 48 G) 56 H) 64

15. What is the molecular weight of a dipeptide (pH 7) formed by joining glycine and proline? (Atomic weights: H = 1; C = 12; N = 14; O = 16; S = 32)

- A) 158 B) 159 C) 160 D) 172 E) 173 F) 190

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-asn-gly F) Each has a net positive charge at pH 7.

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17. Which of the statements about the peptide group is correct? If each one of A-E is incorrect, the answer is F.
- A) It contributes +1 to the overall charge on a polypeptide in aqueous solution at pH 7.
 - B) There is a high degree of freedom of rotation about the peptide bond.
 - C) The peptide bond is denoted by the Greek symbol ϕ (phi)
 - D) Differences in the 3-dimensional structure of polypeptide chains can usually be traced to changes in the torsion angles about the ψ (psi) and ω (omega) bonds.
 - E) The peptide groups in an α -helix have the cis coplanar orientation.
 - F) The above statements are all incorrect.
18. Which of the following statements about the naturally occurring α -helix is incorrect?
- A) It is stabilized by hydrogen bonds between N-H and C=O groups on the backbone of a polypeptide chain.
 - B) It has a right-hand twist if constructed with L-amino acids.
 - C) It has a regular shape because the ϕ , ψ , and ω angles are identical for each residue in an ideal α -helix.
 - D) All R groups protrude out from an α -helix.
 - E) The plane of the peptide group is essentially perpendicular to the helix axis.
 - F) A carbonyl 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): Hair is composed mainly of proteins with a β -sheet conformation.
20. True (A) or False (B): The most important factor stabilizing the tertiary structure of globular proteins is the hydrophobic association of the polar side chains of the amino acid residues.
21. Which one of the following statements about myoglobin (Mb) is CORRECT?
- A) An O_2 molecule can bind to Mb by associating with a pair of lysine residues.
 - B) Since Mb is a globular protein, only a small fraction of its amino acid residues (<50%) exist in α -helical regions.
 - C) Its structure is useful for illustrating protein quaternary structure.
 - D) Mb is an example of a protein that does not need a cofactor for activity.
 - E) A mutation leading to a replacement of a specific glutamate residue by a valine residue in the amino acid sequence of Mb leads to sickle-cell anemia.
 - F) Mb is an example of a conjugated protein.
22. Which of the following statements about carboxypeptidase A is incorrect?
- A) It is an example of a metalloenzyme.
 - B) The mechanism of its action involves a water molecule.
 - C) It is made in the adrenal glands and secreted into the intestines.
 - D) It is involved in the digestion of dietary protein.
 - E) It shortens a polypeptide chain by cleaving the C-terminal amino acid residue from the chain.

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EXAMINATION: Elements of Biochemistry

EXAMINERS: Dr. F. Hruska & A. Scoot

23. Which is a correct statement about the K_m for a reaction catalyzed by an enzyme that shows a hyperbolic v versus $[S]$ curve?
- 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 also 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 $K_m = V_{max}$.
 F) $K_m = 1/2 \times V_{max}$.
24. For an enzyme which follows simple Michaelis-Menten kinetics, what is the V_{max} ($\mu\text{moles}/\text{min}$) if $v = 35 \mu\text{moles}/\text{min}$ when $[S] = K_m$?
 A) 50 B) 70 C) 90 D) 110 E) 130
25. For the enzyme in the previous question (#24), what is the value of K_m if $v = 35 \mu\text{moles}/\text{min}$ when $[S] = 2 \times 10^{-5} \text{ M}$?
 A) 20 μM B) 22 μM C) 25 μM D) 27 μM e) 30 μM
26. The kinetic data in the table below were obtained in a study of an enzyme known to follow Michaelis-Menten kinetics.

| | | | | | | |
|---|------|-------|-------|-------|-------|-------|
| Substrate added (mM) | 0.05 | 0.3 | 1.0 | 4.0 | 12.0 | 100.0 |
| Product formed $\mu\text{mol}/\text{min}$ | 22.9 | 110.8 | 240.0 | 384.0 | 443.1 | 475.3 |

The K_m for this enzyme is approximately

- A) 0.05 mM B) 0.3 mM C) 1.0 mM D) 4.0 mM E) 12.0 mM F) 100 mM
27. Which of the following statements about allosteric enzymes are correct?
 1) They usually have more than one active site. 2) Both substrate and allosteric inhibitor bind at the active site. 3) They are oligomeric proteins. 4) They usually have only one polypeptide chain. 5) They usually show strict Michaelis-Menten kinetics.
- A) 1 & 2 B) 2 & 3 C) 1 & 4 D) 1 & 3 E) 2 & 5 F) 3 & 4 G) 4 & 5
28. When the linear form of D-fructose cyclizes to form a ring, the ring product is called:
 A) a disaccharide B) an ester C) a glycoside D) a hemiacetal E) None of A-D is correct.
29. A ketopentose in its noncyclic, chain form has ? stereoisomeric forms.
 A) 0 B) 1 C) 2 D) 4 E) 6 F) 8

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EXAMINATION: Elements of Biochemistry

EXAMINERS: Drs. F. Hruska & A. Scott

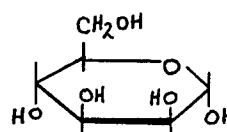
30. True (A) or False (B): The assignment of a sugar to the D or to the L family is based on the configuration of its anomeric carbon.

31. Which of the following is an epimeric pair?

- A) D-Mannose and D-galactose B) D-mannose and D-maltose
C) D-glucose and D-fructose D) D-glucose and D-galactose E) D-glucose and D-ribose

32. The molecule shown is called:

- A) α -D-glucopyranose B) β -D-glucopyranose
C) α -D-galactopyranose D) β -D-galactopyranose
E) α -D-mannopyranose F) β -D-mannopyranose



33. An aqueous solution of ? will not show mutarotation.

- A) D-galactose B) D-glyceraldehyde C) D-glucose
D) D-mannose E) maltose F) D-ribose

34. True (A) or False (B): A 1 M solution of maltose will produce twice as much Cu_2O as a 1 M solution of glucose, when the solutions are treated with an excess of Benedict's solution.

35. Which of the statements A to E about sucrose is false? If you think that they are all correct, your answer is "F".

- A) It is a non-reducing sugar. B) It contains a pyranose ring and a furanose ring.
C) The two units are joined by an α 1 β 2 glycosidic bond.
D) One of the units is an aldose, the other is a ketose.
E) One unit is a pentose sugar and the other is a hexose sugar.
F) None of these statements is false.

36. Given the atomic weights (H= 1; C = 12; O = 16), calculate the molecular weight of cellobiose.

- A) 375 B) 360 C) 351 D) 342 E) 300 F) None of these answers is correct.

37. Which one of the following pairs of polysaccharides is normally found in plant starches?

- A) amylose & glycogen B) cellulose & amylopectin C) glycogen & amylopectin
D) amylose & cellulose E) amylose & amylopectin

38. True (A) or False (B): Glucose, amylose and amylopectin each contain a single hemiacetal group per molecule.

39. Which one of the following pairs of disaccharides will be formed in the incomplete hydrolysis of amylopectin:

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

40. The types of glycosidic bonds linking glucose units in amylopectin 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

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EXAMINATION: Elements of Biochemistry I

EXAMINER: Drs. Hruska & Scoot

Values

LAB SECTION

For Questions 41 and 42 please refer to the following: Paper chromatography with a solvent containing ethanol: ammonia: water (8:1:1) was used to separate the three amino acids; aspartate (Asp), isoleucine (Ile) and serine (Ser).

41. Which of the amino acids would be found closest to the solvent front?
- a) Asp b) Ile c) Ser d) Ile and Ser equally close
e) Cannot be determined
42. Which of the amino acids would have the smallest R_f?
- a) Asp b) Ile c) Ser d) Ile and ser equal and smallest
e) Cannot be determined
43. The Biuret method for measuring protein relies upon one or more of the following:
- (i) Alkaline conditions
(ii) The presence of Cu²⁺
(iii) Titration with acid and base
(iv) Establishment of a calibration curve
(v) Formation of a complex whose absorbance can be determined.
- Which of the above are required conditions?
- a) All of the above b) (i), (ii), (iv) and (v)
c) (i), (ii), (iii) and (iv) d) (iv) and (v) e) (iii)

For questions 44 and 45 please refer to the following: When the absorbance of vitamin D₂ (calciferol) is measured at 264 nm, it follows Beer's Law over a wide range of concentrations. E = 18,200 M⁻¹cm⁻¹ and cell length = 1 cm.

44. If the absorbance has to be ^{at or} above 0.25 what is the lowest concentration of vit D₂ that could be used for analysis?
- a) 1.45 x 10⁻²M b) 7.28 x 10⁴M c) 4.55 x 10³M
d) 1.37 x 10⁻⁵M e) Cannot be determined
45. If the absorbance has to be ^{at or} below 0.85 what is the highest concentration of vit D₂ that could be used for analysis?
- a) 1.55 x 10⁴M b) 2.14 x 10⁴M c) 4.67 x 10⁻⁵M
d) 1.45 x 10⁻²M e) Cannot be determined

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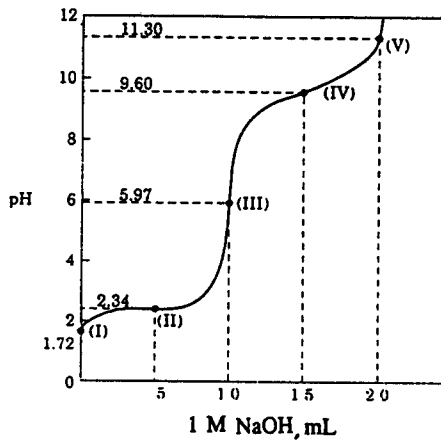
TIME: 2 HOURS

EXAMINATION: Elements of Biochemistry I

EXAMINER: Drs. Hruska & Scoot

Values

For questions 46 to 50 please refer to the following: A 100 mL solution of 0.1M glycine at pH 1.72 was titrated with 1 M NaOH solution. During the titration the pH was monitored and the results were plotted on the graph shown. The key points in the titration are designated I to V on the graph. For each of the questions below, identify the appropriate key point(s) in the titration.



46. At what point is the average net charge of glycine + 1/2?
- a) I b) II c) III d) IV e) V
47. At what point(s) is(are) the pHs equal to the pK_a ?
- a) II and III b) III and IV c) III
d) II and IV e) I and V
48. At what point is the amino group of half the molecules ionized?
- a) I b) II c) III d) IV e) V
49. At what point(s) does glycine have its maximum general buffering capacity?
- a) I and III b) III and V c) II and IV
d) I, III and V e) III
50. At what point would glycine be unable to buffer protons?
- a) I b) II c) III d) IV e) V

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 |