

THE UNIVERSITY OF MANITOBA

DATE: Dec. 9, 1999

Final EXAMINATION

PAPER NO.: 2/3

PAGE NO.: 1 of 9

DEPARTMENT & COURSE NO.: 2.277/60.277

Time: 2 HOURS

EXAMINATION: Elem. Of Biochemistry I

EXAMINER: Drs. Burton & 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 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 60% of your final mark.
5. There is a sheet of blank paper at the end of the exam for rough work.

1. In highly basic solution, pH=13, the dominant form of glycine is?
 

A)  $H_2N - CH_2 - COOH$       B)  $^+H_3N - CH_2 - COOH$       C)  $H_2N - CH_2 - COO^-$

D)  $^+H_3N - CH_2 - COO^-$       E)  $H_2N - \overset{+}{C}H_3 - COO^-$
  
2. For any amino acid with a non-polar R-group, at any pH below the pI of the amino acid, the predominant form in solution will:
 

A) be neutral without any charge      B) have no net charge      C) have a net positive charge

D) have a net negative charge      E) have positive and negative charges in equal concentration.
  
3. What reaction is occurring when a solution of valine at its pI is titrated with NaOH?
 

A)  $-COOH + OH^- \rightarrow -COO^- + H_2O$       B)  $-COOH + -NH_2 \rightarrow -COO^- + -NH_3^+$

C)  $-COO^- + -NH_3^+ \rightarrow -COOH + -NH_2$       D)  $-NH_3^+ + OH^- \rightarrow -NH_2 + H_2O$

E)  $-NH_2 + OH^- \rightarrow -NH^- + H_2O$
  
4. Histidine has pK<sub>a</sub> values of 1.8, 6.0 (R-gp) and 9.2. The percentage of histidine R-gps carrying a positive charge at pH 5.4 is:
 

A) 25%      B) 40%      C) 65%      D) 80%      E) 95%
  
5. Which of the following statements about proteins is FALSE:
 

A) Primary structure determines tertiary structure

B) globular proteins are usually compact

C) carbohydrates or lipids are sometimes attached to proteins

D) Non-polar amino acid side chains are arranged on the surface where they interact with water

E) Most proteins are denatured at high temperature

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6. Threonine and leucine residues tend to disrupt an  $\alpha$ -helix when several occur next to one another in a protein because:
- A) of electrostatic repulsion between Thr and Leu R-groups
  - B) both Thr and Leu are highly hydrophobic
  - C) neither R-gp can H-bond
  - D) of steric hindrance between the bulky Thr and Leu R-groups
  - E) of the formation of covalent bonds between Thr and Leu R-groups
7. Which of the following statements about silk fibroin is UNTRUE:
- A) over 90% of its amino acids are glycine, alanine and serine
  - B) it is an example of an antiparallel  $\beta$ -sheet structure
  - C) it consists of many stacked  $\beta$ -sheets held together by interactions between amino acid R-gps
  - D) the stacked  $\beta$ -sheets are held together by disulfide bridges
  - E) all the glycine R-groups tend to be on one side of each  $\beta$ -sheet.

**USE THE FOLLOWING DATA TO ANSWER QUESTIONS 8 and 9.**

An enzyme which follows Michaelis-Menten kinetics has a  $K_m$  for its substrate of  $1 \times 10^{-5}$  M and, at a substrate concentration of 0.01 M, catalyzes the formation of product at  $v = 20 \mu\text{mole}/\text{min}$ .

8. The reaction velocity ( $v$ ) at a substrate concentration of  $1 \times 10^{-5}$  M is ?  $\mu\text{mole}/\text{min}$ .
- A) 1.8      B) 2.5      C) 5.0      D) 10      E) 15
9. The reaction velocity ( $v$ ) at a substrate concentration of  $1 \times 10^{-6}$  M is ?  $\mu\text{mole}/\text{min}$ .
- A) 1.8      B) 2.5      C) 5.0      D) 10      E) 15

**USE THE FOLLOWING DATA TO ANSWER QUESTIONS 10 and 11.**

An enzyme-catalyzed reaction was carried out with a substrate concentration 2000 times greater than the  $K_m$  for the substrate. After 9 minutes, less than 0.5% of the substrate had been consumed and  $12 \mu\text{mol}$  of product had been formed.

10. If one third as much enzyme and twice as much substrate were used, how long would it take for the same amount of product ( $12 \mu\text{mol}$ ) to be formed?
- A) 1.5 min    B) 3 min    C) 4.5 min    D) 13.5 min    E) 27 min
11. If the enzyme concentration was doubled and the substrate concentration halved, how long would it take for the same amount of product ( $12 \mu\text{mol}$ ) to be formed?
- A) 1.5 min    B) 3 min    C) 4.5 min    D) 13.5 min    E) 27 min

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12. In a plot of  $1/v$  against  $1/[S]$  for an enzyme catalyzed reaction, the presence of a noncompetitive inhibitor will alter:
- A) the intercept on the  $1/v$  axis      B) the intercept on the  $1/[S]$  axis      C) the slope of the plot  
D) Both A and B      E) Both A and C
13. The common (trivial) name of the fatty acid whose structure is  $\text{CH}_3(\text{CH}_2)_4\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$  is ?
- A) palmitoleic acid      B) oleic acid      C) arachidic acid      D) linoleic acid      E) stearic acid
14. The saturated fatty acid of the same chain length as the one in question 13 is ?
- A) palmitoleic acid      B) oleic acid      C) arachidic acid      D) linoleic acid      E) stearic acid
15. Which of the following is NOT a sterol or steroid:
- A) vitamin K      B) vitamin D      C) ergosterol      D) cholecalciferol      E) progesterone
16. Glycerophosphatides form micelles and bilayers principally because:
- A) their hydrophobic tails attract one another  
B) their polar head groups attract one another  
C) their phosphate groups can form cross-links  
D) entropy is maximized when their hydrophobic tails are buried in the interior of the micelle or bilayer  
E) entropy is minimized when their polar heads interact with water at the surface of the micelle or bilayer.
17. Which of the following statements about membranes is FALSE?
- A) the ratio of lipid to protein varies among cell types in the same organism  
B) in a given eukaryotic cell type (e.g. a liver cell) all membranes have the same composition  
C) plasma membranes of mammalian cells contain more cholesterol than mitochondrial membranes  
D) glycoproteins are often found in plasma membrane proteins  
E) the two "halves" or monolayers of a membrane bilayer have different lipid compositions
18. Which of the following statements about peripheral (extrinsic) membrane proteins is TRUE?
- A) they penetrate deeply into or cross the phospholipid bilayer  
B) they behave like typical soluble proteins when released from the bilayer  
C) they have surface regions that are primarily hydrophobic  
D) they are covalently attached to phospholipid head groups  
E) they can be released from the membrane only by detergent treatment

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19. Which of the following statements about integral (intrinsic) membrane proteins is FALSE?
- A) they penetrate deeply into or cross the phospholipid bilayer
  - B) they are usually completely buried in the bilayer
  - C) in many cases their primary structure shows one or more regions rich in hydrophobic amino acids
  - D) parts of their surfaces are primarily hydrophilic and interact with water
  - E) they can be released from the membrane and solubilized by detergent treatment
20. Facilitated diffusion through a cellular membrane ?
- A) is usually irreversible
  - B) is driven by ATP hydrolysis
  - C) is endergonic
  - D) is driven by a difference of solute concentration
  - E) works only with uncharged solutes
21. Which of the following is NOT an aldose?
- A) ribose
  - B) 6-deoxyglucose
  - C) glyceraldehyde
  - D) erythrose
  - E) fructose
22. Which of the following pairs of monosaccharides are epimers?
- A) D-glucose & D-fructose
  - B) D-glucose & D-ribose
  - C) D-glucose & D-galactose
  - D) D-glucose and L-glucose
  - E) D-erythrose & D-ribose
22. Which of the following is not a reducing sugar?
- A) 2-deoxyribose
  - B) sucrose
  - C) isomaltose
  - D) glyceraldehyde
  - E) cellobiose
- USE THE FOLLOWING DATA TO ANSWER QUESTIONS 23 & 24**
- Freshly prepared solutions of  $\alpha$  and  $\beta$ -D-galactose, with identical concentrations, show optical rotations of  $+150.7^\circ$  and  $+52.8^\circ$  respectively. After standing for a prolonged period, both solutions exhibit the same optical rotation,  $+80.2^\circ$ .
23.  $\alpha$  and  $\beta$ -D-galactose are ?
- A) disaccharides
  - B) anomers
  - C) mirror images
  - D) ketoses
  - E) hemiketals
24. The percentage of  $\beta$ -D-galactose in the solution with optical rotation  $+80.2$  is ?
- A) 28%
  - B) 46%
  - C) 66%
  - D) 72%
  - E) 91%
25. Chitin is a polymer of ?
- A) N-acetyl- $\beta$ -D-glucosamine
  - B) N-acetyl- $\alpha$ -D-mannosamine
  - C)  $\beta$ -D-glucose
  - D) isomaltose
  - E) cellobiose

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26. Which of the following pairs of disaccharides will be formed by incomplete (partial) hydrolysis of glycogen?
- A) maltose & sucrose      B) maltose and isomaltose      C) maltose and lactose  
 D) isomaltose and cellobiose      E) maltose and chitobiose
27. Uridine is ?
- A) a purine ribonucleotide      B) a pyrimidine ribonucleoside      C) a deoxyribonucleotide  
 D) a mononucleotide      E) UMP
28. In a double-stranded nucleic acid cytosine typically base-pairs with ?
- A) guanine      B) cytosine      C) thymine      D) adenosine      E) uracil
29. In double-stranded DNA the ?
- A) proportion of bases that are purines must be the same in both strands  
 B) planes of the bases lie parallel to the long axis of the DNA molecule  
 C) 2' hydroxyl groups of ribose participate in hydrogen bonding  
 D) two strands are antiparallel  
 E) adenine content of one strand must be equivalent to the thymine content in both the same strand and the complementary strand
30. A segment of a single DNA strand has the following base sequence:  
 (5') GTGATCAAGC (3'). In a double stranded DNA, which of the following represents the complementary sequence?
- A) (5') CACTAGTTCG (3')      B) (5') CACUAGUUCG (3')      C) (5') CACUTTCGCCC (3')  
 D) (5') GCTTGATCAC (3')      E) (5') GCCTAGTTUG (3')
31. When a mixture of 3-phosphoglycerate and 2-phosphoglycerate is incubated at 25° with phosphoglycerate mutase until equilibrium is reached, the final mixture contains six times as much 2-phosphoglycerate as 3-phosphoglycerate. The  $\Delta G^\circ$  for the reaction 3-phosphoglycerate  $\rightarrow$  2-phosphoglycerate is ?  
 (R = 8.315 J / mol.degree)
- A) zero      B) +4.44 kJ/mol      C) -4.44 kJ/mol      D) -1.93 kJ/mol      E) -0.37 kJ/mol
32. For the reaction A  $\rightarrow$  B,  $\Delta G^\circ$  is -60 kJ/mol. The reaction is started with 10 mmol of A; no B is initially present. After 8 hours, analysis reveals the presence in the reaction of 7 mmol A and 3 mmol B. These results ?
- A) indicate equilibrium has been reached  
 B) indicate formation of B is thermodynamically unfavourable  
 C) are impossible, since  $\Delta G^\circ$  is -60 kJ/mol  
 D) indicate formation of B is slow and equilibrium has not yet been reached  
 E) indicate an enzyme has shifted the equilibrium toward A

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33. The initial electron acceptor in the fermentation of glucose to ethanol is  $\text{NAD}^+$ . The final electron acceptor in this pathway is ?
- A) pyruvate      B) ethanol      C)  $\text{NADH} + \text{H}^+$       D) acetaldehyde      E) acetate
34. The conversion of glyceraldehyde-3-phosphate to 3-phosphoglycerate during glycolysis does NOT involve ?
- A) formation of an acid anhydride bond      B) substrate-level phosphorylation  
C) oxidation and reduction of substrates      D) formation of an ester bond  
E) phosphoglycerate kinase
35. Which of the following is a CORRECT partial sequence of intermediates in the TCA cycle?
- A) isocitrate  $\rightarrow$  citrate  $\rightarrow$  alpha-keto glutarate  
B) isocitrate  $\rightarrow$  alpha-ketoglutarate  $\rightarrow$  succinyl-S-CoA  
C) alpha-ketoglutarate  $\rightarrow$  succinate  $\rightarrow$  malate  
D) malate  $\rightarrow$  succinate  $\rightarrow$  fumarate  
E) citrate  $\rightarrow$  isocitrate  $\rightarrow$  oxaloacetate
36. Conversion of 1 mole of pyruvate to 3 moles of  $\text{CO}_2$  via the reactions of the TCA cycle also yields \_\_\_\_\_ moles of  $\text{NADH} + \text{H}^+$ , \_\_\_\_\_ moles of  $\text{FADH}_2$ , and \_\_\_\_\_ moles of GTP.
- A) 3; 2; 0      B) 4; 2; 1      C) 4; 1; 1      D) 3; 1; 1      E) 2; 2; 2
37. Complete degradation of 1 mole of fructose-1,6-bisphosphate to  $\text{CO}_2$  and  $\text{H}_2\text{O}$  via the reactions of glycolysis and the TCA cycle followed by electron transport and oxidative phosphorylation, leads to the net synthesis of how many ATP equivalents?
- A) 18      B) 24      C) 30      D) 40      E) 60
38. Which of the following statements about electron transport in eukaryotic cells is FALSE?
- A) energy released during electron transport is conserved as a proton gradient  
B) the components of the electron transport chain are located in the mitochondrial matrix  
C) electron transport results in pumping of protons out of the mitochondrial matrix  
D) cytochrome c transfers electrons from complex III to complex IV of the electron transport chain  
E) oxidation of 1 mole  $\text{NADH} + \text{H}^+$  via the electron transport chain consumes one oxygen atom

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39. Which of the following statements about electron transport and oxidative phosphorylation in eukaryotic cells is FALSE?
- A) electron transfer in mitochondria is accompanied by vectorial proton transport across the inner membrane
  - B) the energy released when protons flow down their concentration gradient from the mitochondrial matrix to the intermembrane space is used by the membrane ATP synthase to generate ATP
  - C) coupling of ATP synthesis to electron transport requires a closed membrane system with an inside and outside
  - D) ubiquinone transfers electrons from complex II to complex III of the electron transport chain
  - E) ATP synthesis can be uncoupled from electron transport by compounds that carry protons across the inner membrane
40. Approximately what percentage of the energy released during the mitochondrial oxidation of 1 mole of  $\text{FADH}_2$  via electron transport is conserved as ATP? ( $E^\circ$  values for the  $\text{FAD}/\text{FADH}_2$  and  $\frac{1}{2}\text{O}_2/\text{H}_2\text{O}$  half cells are  $-0.219\text{ V}$  and  $+0.816\text{ V}$  respectively. The  $\Delta G^\circ$  for ATP hydrolysis is  $-30.5\text{ kJ/mol}$  and the Faraday constant =  $96.5\text{ kJ/V}\cdot\text{mol}$ )

A) 15    B) 30    C) 40    D) 50    E) 60

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LAB SECTION (Questions 41 to 50)

41. Which of the following statements describe the enzyme assay used in the enzyme kinetics experiment?
1. The substrate used was phenolphthalein.
  2. The product was formed by removing a phosphate from the substrate.
  3. Enzyme action was stopped by making the assay mixture strongly basic.
  4. In order to visualise the product biuret reagent was added.
  5. A calibration curve was constructed using bovine serum albumin
- A) 1, 2 and 3    B) 2 and 3    C) 2, 3 and 4    D) 1, 2, 3 and 4  
E) All of the above
42. If the enzyme concentration used in an assay was doubled how would this affect the values of  $K_m$  and  $V_{max}$ ?
- A)  $K_m$  doubled     $V_{max}$  doubled  
B)  $K_m$  doubled     $V_{max}$  unchanged  
C)  $K_m$  unchanged     $V_{max}$  doubled  
D)  $K_m$  unchanged     $V_{max}$  unchanged  
E)  $K_m$  halved     $V_{max}$  doubled
43. A graph drawn from the results of the experiment where enzyme activity was measured in response to varying substrate concentrations would be expected to show the following relationship.
- A) bell-shaped    B) sigmoidal    C) Henderson-Hasselbach  
D) hyperbolic    E) Lineweaver-Burke
44. Which of the following statements about a calibration curve are true?
1. A calibration curve is used to find the concentration of an unknown.
  2. A calibration curve is constructed using various concentrations of the unknown or a similar substance.
  3. The substance is subjected to the same assay as the unknown and results measured, for example absorbance of the product.
  4. If the absorbance of an unknown falls outside the range of a linear calibration curve, the line can be extended to enable one to find the concentration of the unknown.
  5. An example of a calibration curve is the effect of pH on enzyme activity.
- A) 1    B) 1, 2 & 3    C) 1 & 3    D) 1, 2, 3 & 4    E) 1, 2, 3, 4 & 5
45. Three chemical tests, Barfoed's, Bial's and Seliwanoff's, were performed in the order listed on the following carbohydrate solutions; glucose, maltose, fructose and xylose. Each test led to the identification of one of the carbohydrates which could then be eliminated. Which one of the four carbohydrates remained after this process of elimination?
- A) Glucose    B) Maltose    C) Fructose    D) Xylose    E) Cannot be determined



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46. Which of the following statements describe Bial's test?
1. It is used to distinguish between pentoses and hexoses
  2. The reagent contains copper acetate
  3. The assay conditions are acidic
  4. The copper ion is oxidised
  5. A furfural intermediate is formed
- A) All of the above    B) 1, 2, 3 and 4    C) 1, 3 and 5    D) 1 and 5  
E) None of the above
47. Which of the following statements describe the Molisch test?
1. It is used to detect ketoses
  2. The result with sucrose is positive
  3. A furfural intermediate is formed
  4. It requires orcinol and ferric ions
  5. Red condensation products are formed
- A) All of the above    B) 1, 3, 4 and 5    C) 1, 2, 3 and 5    D) 2 and 3    E) 2
48. Which of the following statements describe the role of iso-pentyl alcohol: ethyl acetate in the isolation of DNA from salmon sperm nuclei?
1. It disrupts the nuclei
  2. It frees the DNA from nucleoproteins
  3. It precipitates the protein
  4. It precipitates the DNA as sticky fibres
  5. It precipitates RNA as a flocculent precipitate
- A) 1 and 2    B) 3    C) 1, 2 and 3    D) 4 and 5    E) 3, 4 and 5
49. When DNA was isolated from Salmon sperm one of the steps separated the DNA from RNA. Which of the following statements relate to this step?
1. It is achieved because DNA is double-stranded whereas RNA is single-stranded
  2. It is achieved using ethanol
  3. It requires the presence of citrate ions
  4. DNA is precipitated by ethanol whereas RNA remains in solution
  5. DNA is denatured by SDS and forms sticky fibres whereas RNA forms a flocculent precipitate.
- A) 1 and 2    B) 1, 2 and 4    C) 2, 4 and 5    D) 1, 3 and 5    E) 1, 2, 4 and 5
50. When doubled-stranded DNA is subjected to the action of DNase, which change does not occur?
- A) Phosphodiester linkages are broken
  - B) The viscosity of the solution decreases.
  - C) The molecule is broken down to give single nucleotides
  - D) The helical structure is destroyed
  - E) The covalent bond between the base and the pentose remains intact.

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**1999/2000 (00R)**

**Final Exam Answers**

**December 09 , 1999**

1. C
2. C
3. D
4. D
5. D
6. D
7. D
8. D
9. A
10. E

21. E
22. ~~C~~ B
23. B
24. D
25. A
26. B
27. B
28. A
29. D
30. D

41. B
42. C
43. D
44. B
45. A
46. C
47. D
48. B
49. A
50. C

11. C
12. E
13. D
14. E
15. A
16. D
17. B
18. B
19. B
20. D

31. C
32. D
33. D
34. D
35. B
36. C
37. D
38. B
39. B
40. B