

THE UNIVERSITY OF MANITOBA

December 3, 1997

Final EXAMINATION

Paper NO: 3/28

PAGE NO: 1 of 7

DEPARTMENT & COURSE NUMBER: 2.277/60.277

TIME: 2 HOURS

EXAMINATION: Elements of Biochemistry

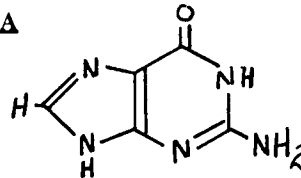
EXAMINER: Drs. F. Hruska & A. Scott

1. You must mark your answer sheet with a pencil (not a pen).
2. Put your name and enter your student number on the answer sheet.
3. The examination, worth 60% of your final grade, consists of multiple choice questions. Choose the answer that you think is best and record your choice on the answer sheet. There is only **ONE CORRECT** answer.
4. At the end of the exam is blank paper for rough work.

**PART A**

1. The name of the molecule shown is:

A) uracil B) thymidine C) guanidine  
D) adenine E) none of the above



2. ? is a correct statement about the sugar units in RNA.
  - A) They are ketopentoses.
  - B) They are joined to the N1 atom of a purine base or the N9 atom of a pyrimidine base.
  - C) They are in a pyranose ring form.
  - D) When part of an RNA chain, they undergo interconversion between their chain and ring forms.
  - E) All of these statements are incorrect.
3. A nucleoside isolated from RNA was shown by chemical analysis to have 4 oxygen atoms and 5 nitrogen atoms in its molecule. The nucleoside is ?.
  - A) adenosine
  - B) cytidine
  - C) guanosine
  - D) uridine
  - E) none of these
4. Statements ? about double helical DNA are correct.
  1. The two strands are parallel.
  2. Watson and Crick proposed that DNA exists as a right-handed double helix.
  3. The two strands must have identical sequences.
  4. An adenine in one strand forms three hydrogen bonds to a co-planar thymine base in the other strand.
  5. The 2'-deoxyribonucleotides in a strand are linked by 3',5'-phosphodiester bonds.
  - A) 1 & 5
  - B) 2 & 4
  - C) 2 & 5
  - D) 3 & 4
  - E) 1 & 3.
5. True (A) or False (B): Both keto oxygens of a cytosine base in one strand of double helical DNA are involved in hydrogen bond interactions with a guanine base in the other strand.
6. For the reversible reaction  $A \rightleftharpoons B$ ,  $\Delta G^\circ = +15 \text{ kcal/mol}$ . 5 mmol of B and 5 mmol of A are dissolved in a volume of water; no enzyme was included. After 24 hours, there was no detectable change in the concentration of A or B. Which is a correct statement about this situation?
  - A) A and B are at equilibrium, so no change is expected.
  - B) The formation of B from A is thermodynamically favorable.
  - C) B would have increased at the expense of A if the appropriate enzyme had been added.
  - D) The formation of B from A is exergonic.
  - E) None of these statements is correct

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EXAMINER: Drs. F. Hruska & A. Scoot

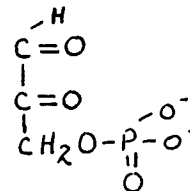
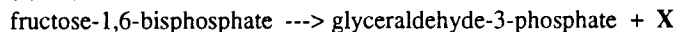
7. The following reaction is catalyzed by the enzyme phosphoglucomutase (PGM) and has a  $\Delta G^\circ = -1.8$  kcal/mole at 25°C. ( $R = 1.987$  cal/mol•K)



The equilibrium constant for this reaction is

- A)  $1.76 \times 10^{-16}$     B)  $9.12 \times 10^{-4}$     C)  $4.77 \times 10^{-2}$   
 D)  $2.09 \times 10^1$     E)  $1.10 \times 10^{-3}$
8. Use the information in Question 7 to solve this problem. If PGM is added to a solution ( $T = 25^\circ\text{C}$ ) that contains initially 0.1 M G6P but no G1P, the solution quickly reaches equilibrium. Which answer best approximates the equilibrium concentrations of G1P and G6P?  
 A)  $[\text{G6P}] = 0.095$  M;  $[\text{G1P}] = 0.0045$  M    B)  $[\text{G6P}] = 0.075$  M;  $[\text{G1P}] = 0.025$  M  
 C)  $[\text{G6P}] = 0.055$  M;  $[\text{G1P}] = 0.045$  M    D)  $[\text{G6P}] = 0.020$  M;  $[\text{G1P}] = 0.080$  M  
 E)  $[\text{G6P}] = 0.010$  M;  $[\text{G1P}] = 0.090$  M
9. Which is the incorrect statement about the sequence of 2 steps in glycolysis that starts with glyceraldehyde-3-phosphate and ends with 3-phosphoglycerate?  
 A) It consumes  $\text{NAD}^+$ .    B) Involves transfer of  $[\text{H}:]^-$  (hydride ion) to a reducing agent.  
 C) Leads to an increase in high energy phosphate bonds.    D) Requires a kinase and a dehydrogenase.    E) It consumes ADP.
10. Which is the correct statement about the sequence of 2 steps in glycolysis that starts with 2-phosphoglycerate and ends with pyruvate?  
 A) It requires a dehydrogenase.    B) consumes ADP.    C) Consumes a water molecule.  
 D) One of its enzymes requires a thiamin derivative.    E) None of these statements is correct.
11. Two enzymes that catalyze steps in Stage I (Preparatory Stage) of glycolysis are ?.  
 1) triose phosphate isomerase.    2) glyceraldehyde-3-phosphate dehydrogenase.  
 3) hexokinase.    4) phosphoglycerate mutase.    5) pyruvate kinase.  
 A) 1 & 3    B) 2 & 4    C) 3 & 5    D) 1 & 4    E) 2 & 5

12. True (A) or False (B): The molecule shown is the structure of X in the following reaction in glycolysis:



13. Statement(s) ? about  $\text{NAD}^+$  are true.  
 1) It has 3 phosphorus atoms.    2) It has one sulfur atom.    3) It has 2 ribose units.  
 4) Its adenine unit is positively charged.    5) It is a coenzyme of pyruvate kinase.  
 A) 1 & 4    B) 2 & 5    C) only 3    D) 2 & 4    E) only 5.
14. ? best represents the products of the anaerobic glycolysis of one mole of glucose.  
 A) 2 lactic acid, 4 ATP    B) 1 lactic acid, 2 ATP, 3  $\text{CO}_2$ .    C) 2 ethanol, 2 ATP.  
 D) 2 lactic acid, 2 ATP    E) 2 lactic acid, 2 ATP, 2 NADH, 2  $\text{H}^+$ .
15. True (A) or False (B):  $\alpha$ -Ketoglutarate has the same number of carbon atoms as aspartate.

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16. Statement ? about the Krebs (TCA) Cycle is incorrect.  
 A) It is an amphibolic pathway. B) It is inhibited by malonate. C) One of its reactions requires biotin. D) One of its reactions involves substrate level phosphorylation.  
 E) It plays an important role in cellular respiration.
17. ? is NEITHER a substrate NOR a product of the reaction catalyzed by the pyruvate dehydrogenase complex.  
 A) lactic acid B) coenzyme A C) CO<sub>2</sub> D) NADH E) acetyl-CoA
18. ? is an incorrect statement about the sequence of reactions catalyzed by the first two enzymes of the Krebs (TCA) cycle.  
 A) It results in a decrease in oxaloacetate. B) Isocitrate is a product. C) ATP is neither consumed nor generated. D) It involves the hydrolysis of a high energy thioester bond.  
 E) Ascorbate is an intermediate.
19. True (A) or False (B): Exactly half of the steps in the TCA cycle require either FAD or NAD+.
20. In the TCA (Citric Acid) Cycle, fumarate is formed by ? of its immediate precursor.  
 A) hydrolysis B) reduction C) dehydration D) oxidation E) None of A-D.
21. In the complete, aerobic oxidation of a glucose molecule, ? different enzymes or enzyme complexes catalyze a step involving an "oxidative decarboxylation".  
 A) 6 B) 5 C) 4 D) 3 E) 2.
22. The enzyme ? catalyzes the formation of oxaloacetate in the Citric Acid (TCA) Cycle.  
 A) aconitase B) fumarase C) citrate synthase D) malate dehydrogenase  
 E) oxaloacetate synthase.
23. The correct statement(s) about the reaction that converts pyruvate to oxaloacetate by the reaction covered in class are ?.  
 1) It is an "Amphoteric Reaction". 2) It requires ATP. 3) It requires NADH.  
 4) It evolves CO<sub>2</sub>. 5) It requires biotin.  
 A) 3 & 5 B) 1 & 4 C) 2 & 5 D) 2 & 4 E) 1 & 3
24. The structure below is a part of ?.  
 A) NAD+ B) FAD C) coenzyme A.  
 D) lipoic acid E) thiamin pyrophosphate
- The diagram shows a thiazolium ring, a five-membered heterocyclic ring containing a nitrogen atom with a positive charge and a sulfur atom. The ring is fused to a methyl group (CH<sub>3</sub>) and a carbonyl group (C=O).
25. The enzyme that converts pyruvate to acetaldehyde during alcohol fermentation in yeast requires a coenzyme derived from the vitamin ?.  
 A) niacin B) riboflavin C) pantothenate E) biotin. E) None of A-D.
26. Riboflavin is a vitamin whose active coenzyme usually participates with a ? enzyme.  
 A) dehydrogenase B) hydrolase C) isomerase D) kinase E) carboxypeptidase

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27. In a molecule of ?, an intermediate in the TCA Cycle, the number of carbon atoms is equal to the number of oxygen atoms.  
A) citrate B) isocitrate C) fumarate D) malate E) oxaloacetate.
28. Which of the following conversions involves a total of 5 different B vitamins?  
A) acetaldehyde to ethanol. B) citrate to isocitrate C) pyruvate + CO<sub>2</sub> --> oxaloacetate  
D) isocitrate to  $\alpha$ -ketoglutarate. E)  $\alpha$ -ketoglutarate to succinyl-CoA.
29. ? electrons are needed for the reduction of a molecule of oxygen gas (O<sub>2</sub>) to water.  
A) 1 B) 2 C) 4 D) 6 E) 8.
30. Statement ? about coenzyme Q is correct.  
A) It transports electrons from complexes I and II to complex III of the electron transport system. B) It contains several peptide groups. C) It has a long, polar chain of isoprene units. D) It is located in the cytosol. E) It is necessary for anaerobic oxidation of glucose.
31. When one mole of electrons, initially at point A (voltage = -0.30 V), flows to point B (unknown voltage), 20 kcals of free energy are released and made available for doing useful work. The voltage at point B is ? volts. (Faraday's constant = 23.06 kcals/volt)  
A) -0.73 V B) -0.57 V C) 0.57 V D) 0.73 V
32. Which of the following statements about cytochrome-c is incorrect?  
A) It is a membrane-bound protein. B) It is present in mitochondria.  
C) It has a heme prosthetic group that is similar to that of myoglobin.  
D) It transfers electrons between Complex III and Complex IV.  
E) Its prosthetic group contains a copper atom.
33. Statement ? about the formation of ATP by "oxidative phosphorylation" is incorrect  
A) The enzyme "ATP synthase" is required.  
B) As protons flow through the electron transport chain, electrons are pumped from the matrix into the "intermembrane space".  
C) The ATP is formed in the matrix of the mitochondria.  
D) The operation of the electron transport chain lowers the pH in the intermembrane space relative to the pH in the matrix.  
E) ATP synthesis requires the flow of H<sup>+</sup> ions across the inner mitochondrial membrane.
34. What is the net increase in high-energy phosphate bonds when one mole of pyruvate is completely metabolized under aerobic conditions?  
A) 3 B) 6 C) 9 D) 12 E) 15
35. How many of the high-energy (P~O) bonds generated during the aerobic oxidation of one molecule of glucose are formed by "Oxidative Phosphorylation"?  
A) 4 B) 6 C) 32 D) 34 E) 36
36. The name of molecule with the formula CH<sub>3</sub>(CH<sub>2</sub>)<sub>4</sub>CH=CHCH<sub>2</sub>CH=CH(CH<sub>2</sub>)<sub>7</sub>COOH is :  
A) linoleic B) oleic acid C) palmitic acid D) palmitoleic acid E) stearic acid

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37. Arrange the following fatty acids in the order of increasing melting point.  
1) oleic acid 2) stearic acid 3) linoleic acid 4) palmitic acid  
A) 3, 1, 4, 2 B) 2, 4, 1, 3 C) 3, 1, 2, 4 D) 4, 2, 1, 3 E) 1, 3, 4, 2
38. About ? kilograms of the simple triacylglycerol containing palmitoleic acid groups can be completely hydrogenated by 1 kilogram of hydrogen gas (H<sub>2</sub>).  
Atomic weights: H = 1; C = 12; O = 16  
A) 109 B) 133 C) 155 D) 178 E) 192
39. Statement ? about cholesterol is incorrect.  
A) It is an important component of membranes in heart tissue.  
B) It contains three 6-membered rings and one 5-membered ring.  
C) It is not very soluble in water.  
D) It is an amphipathic molecule.  
E) It has a branched, polar side chain attached to the 5-membered ring.
40. Which of the following statements about biological membranes is incorrect?  
A) Membranes lipids are generally amphipathic molecules.  
B) They are made primarily of lipid and carbohydrate.  
C) When E. coli (bacteria) grow at low temperatures, the lipids in their membrane have a higher weight percent of unsaturated fatty acids than they do at higher temperatures.  
D) The Fluid Mosaic Model states that lipid molecules are free to move about, but tend to remain in one layer of the lipid bilayer.  
E) Phosphatidyl choline is an important component of membranes.

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EXAMINATION: Elem. of Biochemistry I

EXAMINER: Drs. Hruska/Scoot

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**LAB SECTION (Questions 41 to 50)**

41. The R-group carboxyl of aspartate has a pka of 4.0. What percentage of this group will be unprotonated at a pH of 4.6?
- A) 20%      B) 50%      C) 60%      D) 80%      E) 100%
42. 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

**For Questions 43, 44 and 45, please refer to the following:**

The chemical tests listed below are used to distinguish between different carbohydrates

- 1) Barfoed's Test      2) Benedict's Test      3) Bial's Test      4) Molisch Test  
5) Seliwanoff's Test

43. Which of the tests rely upon the formation of furfural or one of its derivatives?
- A) 1 & 2      B) 3 & 5      C) 2 & 3      D) 4      E) 3, 4 & 5
44. Which three of these tests when used in sequence would enable you to distinguish between the following five carbohydrate solutions; glucose, maltose, sucrose, ribose and fructose?
- A) 1, 3 & 5      B) 2, 3 & 5      C) 4, 1 & 3      D) 1, 2 & 3      E) 4, 3 & 5
45. Which one of the tests involves a reagent containing copper acetate in an acidic environment?
- A) 1      B) 2      C) 3      D) 4      E) 5
46. A value for  $T_M$  can be determined from a graph showing the effect of DNase on the viscosity of DNA.
- A) True      B) False

continued on next page...

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EXAMINATION: Elem. of Biochemistry I

EXAMINER: Drs. Hruska/Scott

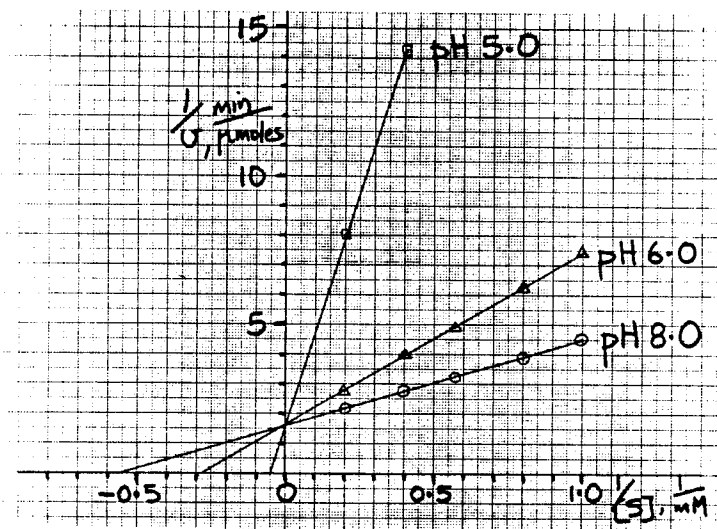
47. Which of the following statements about the  $T_M$  for DNA are true?

- 1) It is the temperature where half the DNA is single stranded and half is double stranded.
- 2) It is the temperature at the midpoint of DNA denaturation.
- 3) It is the midpoint of the transition temperature range for the DNA.
- 4) It is the melting temperature of DNA.
- 5) Its value depends upon the base composition of the DNA.

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

For Questions 48, 49 and 50, please refer to the following graph

Lineweaver - Burk plots showing the effect of three different pH levels on a particular system ([S] varied [E] constant)



48. What is the value for  $K_M$  at the pH where the enzyme is the most active of the three?

A) 20.00 mM                      B) 3.57 mM                      C) 1.82 mM                      D) 0.55 mM                      E) 0.28 mM

49. What type of inhibitor is  $H^+$  in this system?

A) Competitive                      B) Noncompetitive                      C) Uncompetitive  
D) Allosteric                      E) It is not an inhibitor

50. Assuming there is a group at the active site with a  $pK_a$  of 6.0, do these data suggest that substrate binding requires this group to be

A) protonated?                      B) unprotonated?

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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