ANSWERS

THE UNIVERSITY OF MANITOBA **STUDENT NAME:**_____

December 18, 2014 6:00 pm – 9:00 pm

CHEM / MBIO 2770 Elements of Biochemistry I Final Examination

Frank Kennedy – Brown Gym Seats 147-269

Examiners: Dr. H. Perreault and Dr. E. Nichols

Instructions

- *Please mark the Answer Sheet using PENCIL ONLY.*
- *Enter your NAME and STUDENT NUMBER on the Answer Sheet and on the Exam Sheet.*
- *The exam consists of 45 multiple-choice questions and 5 written questions. Enter your multiple-choice answers on the Bubble sheet and write the other answers on the exam questionnaire. Hand in the whole questionnaire at the end.*
- *There is only 1 correct answer for each multiple-choice question.*
- *Please read each question CAREFULLY.*
- *Please protect your answers from the view of other students.*
- *Scratch Paper is available at the back of the examination.*

LECTURE SECTION (Questions 1 to 35: answer on the bubble sheet; 1.89 pts per question)

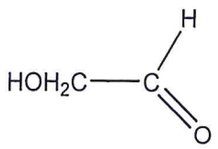
1. All chemical and biochemical change involves rearrangements of _____

A) protons
B) carbon atoms
C) electrons.
D) nitrogen atoms
E) catabolism

2. If the enthalpy change of a reaction is +6.87 kJ/mol; the reaction is:

A) At equilibrium
B) Exergonic
C) Endergonic
D) Endothermic
E) Of first kinetic order

3. What functional groups are present on this molecule?



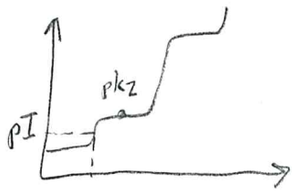
A) Hydroxyl and ketone
B) Hydroxyl and aldehyde
C) Amino and ester
D) Ether and aldehyde
E) Carboxyl and hydroxyl

4. Which of the following does NOT describe chemical properties of amino acids?

A) Sides chains are different among all amino acids
B) At pH 7, all amino acids are zwitterions
C) At pH 1, all carboxyl groups are COOH
D) At pH 12, all amino groups are NH_2
E) Some side chains of amino acids are isomeric

9. NaOH solution (25 mL, 0.1M) was added to 100 mL of 0.1 M aspartate solution, pH = pI. What is the new pH? pKa values for aspartate are 1.88, 3.65 (R-group) and 9.60.

A) 2.76
B) 3.24
C) 3.17
D) 3.65
E) 9.60



moles NaOH = 0.025 x 0.1 = 0.0025
moles asp = 0.1 x 0.1 = 0.01
$pH = pk_2 + \log \frac{[HA^{2-}]}{[H_2A^-]} = 3.65 + \log \frac{[0.0025]}{(0.01-0.0025)}$
$= 3.17$

H_3A
$\downarrow pk_1$
H_2A^-
$\downarrow pk_2$
HA^{2-}
$\downarrow pk_3$
A^{3-}

10. In gel sieving chromatography, ____i____ proteins don't enter the porous beads and so run ____ii____ through the column whereas ____iii____ proteins enter and exit the beads and elute more ____iv____

A) i = small; ii = quickly; iii = big; iv = slowly.
B) i = big; ii = quickly; iii = small; iv = slowly.
C) i = big; ii = slowly; iii = small; iv = quickly.
D) i = small; ii = slowly; iii = big; iv = quickly.
E) i = big; ii = small; iii = quickly; iv = slowly.

11. By adding SDS (sodium dodecyl sulfate) during the electrophoresis of proteins, it is possible to:

A) determine a protein's isoelectric point.
B) determine an enzyme's specific activity.
C) determine the amino acid composition of a protein.
D) preserve a protein's native structure and biological activity.
E) separate proteins exclusively on the basis of molecular weight.

12. An enzyme has a K_m for its substrate of 6.3×10^{-5} M and a V_{max} of 8.1×10^{-3} moles per litre per second. What would the initial rate of reaction be for this enzyme at a substrate concentration of 2.0×10^{-6} M?

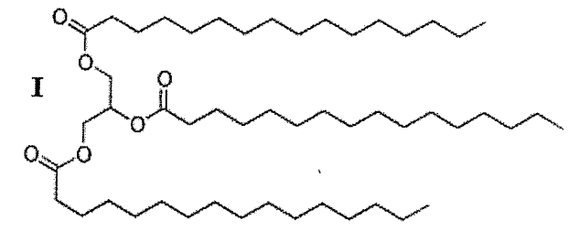
$v_0 = \frac{8.1 \times 10^{-3} \ (2 \times 10^{-6} M)}{(6.3 \times 10^{-5}) + (2 \times 10^{-6} M)} = 2.5 \times 10^{-4}$

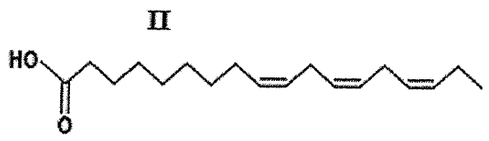
A) 2.5×10^{-3} moles per litre per second
B) 0.255 moles per litre per second
C) 2.5×10^{-4} moles per litre per second
D) $4.05 \times 10^{+3}$ moles per litre per second
E) Cannot be determined from the information given.

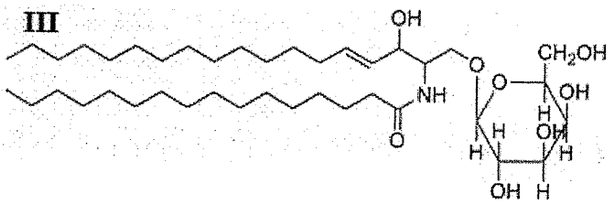
13. Enzymes have active sites which have the greatest complementarity to the:

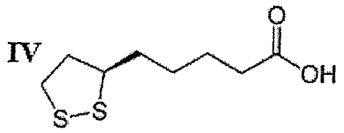
A) coenzyme
B) transition state of the substrate
C) ransition state of the product
D) both substrate and product
E) none of the above.

18. Find the best name for each molecule shown below:







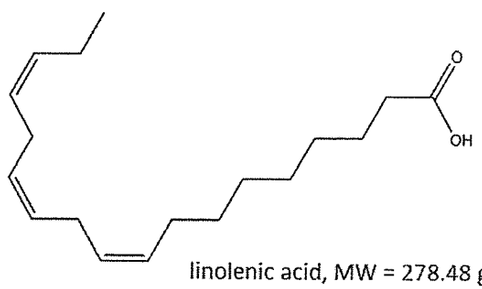


A) I saponic acid; II cholesterol; III ganglioside; IV adipic acid.
B) I triglyceride; II omega-3 fatty acid; III cerebroside; IV lipoic acid.
C) I saturated fat; II unsaturated fat; III diglyceride; IV cholesterol.
D) I glycerin; II omega-6 fat; III ADP; IV serine.
E) I triglyceride; II palmitic acid; III sphingomyelin; IV cysteine.

19. Identify the **CORRECT** statement:

A) The fluid mosaic model of a membrane assumes that lipids travel rapidly around the bilayer but all proteins are fixed and unable to move.
B) Eukaryotic cells have no membranes around their organelles.
C) The hydrophobic inside of a membrane is host to fat-soluble molecules.
D) H^+ membrane channels are opened by enzymes temporarily.
E) Integral membrane proteins are held to the surfaces of membranes by covalent bonds to carbohydrates.

20. What would be the iodine number of this compound? Calculate in terms of I added.



linolenic acid, MW = 278.48 g/mol
I: 126.9 g/mol

278.48 g → 3(126.9) g
100 g → x

x = 136.7

A) 136.7
B) 73.1
C) 380.7
D) 3
E) 273.4

25. Phosphoglycerate mutase catalyzes the reaction:

3-phosphoglycerate ↔ 2-phosphoglycerate. The equilibrium constant for this reaction is 0.169 at 298 K. (R = 8.314 J/mol.K). The $\Delta G'^0$ for this reaction is:

A) +1.9 kJ/mol
B) +4.4 kJ/mol
C) -4.2 kJ/mol
D) 6.8 X 10^{-5} kJ/mol
E) 306.5 kJ/mol

$\Delta G = -RT \ln K_{eq}$
$= -8.314 \times 298 \times \ln 0.169 = 4405$ J/mol
$= 4.4$ kJ/mol

26 The conversion of one mole of glucose to two moles of acetyl-coA, by the glycolytic pathway and the "link" between glycolysis and the Krebs cycle, produces:

A) 4 H^+, 2NAD^+, 2ADP, 2 Pi
B) 4 ATP, 2 NADH, 2 pyruvates, 2 acetyl-coA, 2 CO_2
C) 2ADP, 2CO_2, 2 acetyl-coA and 2 NADH.
D) 2 ATP, 4 NADH, 2 acetyl co-A and 2 CO_2.
E) 1 pyruvate, 2 Pi., 2 ADP and 4 NADH.

27. In the processes of glycolysis and in the Krebs cycle, which enzymes are responsible for substrate-level phosphorylation?

A) Phosphoglycerate kinase, pyruvate kinase, succinyl coA synthetase.
B) Glyceralsehyde-3-phosphate dehydrogenase; malate dehydrogenase.
C) Lactate dehydrogenase; succinyl CoA-synthetase; ATP synthase.
D) Phosphofructokinase; pyruvate dehydrogenase; succinyl CoA-synthetase.
E) Hexokinase; phosphofructokinase.

28. Why is ATP an indicator of a cell's high energy status?

A) It is formed through the action of ATP synthase
B) It is formed by phosphorylation of ADP, which has a negative ΔG
C) Is has the highest possible level of phosphorylation in a nucleotide
D) It can accept an inorganic phosphate and the reaction has a negative ΔG
E) It can phosphorylate other molecules and the reaction has a negative ΔG

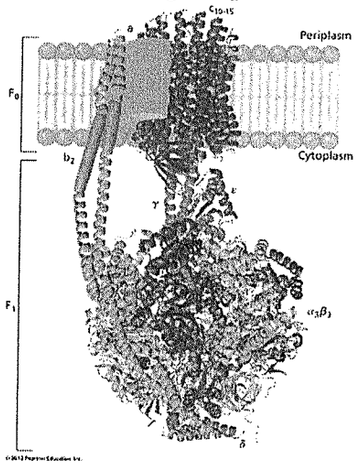
29. Which statement best describes the action of ATP synthase?

A) Is has a rotating fluorescent arm to transfer electromagnetic energy used for ATP synthesis
B) It makes ATP from one AMP and two inorganic phosphates
C) Three active sites; in turn, make ATP from one ADP and an inorganic phosphate
D) The whole protein complex rotates relative to the membrane; generating mechanical energy
E) It uses mechanical energy from H_2O produced at the end of the electron cascade.

34. What is INCORRECT about the role of FAD in the link between glycolysis and the Krebs cycle?

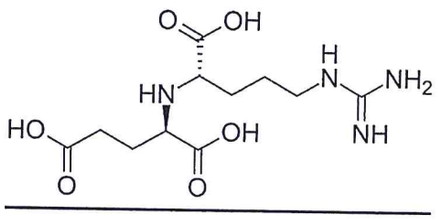
A) It is reduced to $FADH_2$
B) It regenerates lipoic acid through oxidation
C) It is in its oxidized state
D) It reduces lipoic acid
E) All are true

35. The picture below shows the ____i____ structure of ATP synthase, which is an assembly of polypeptides in their ____ii____ structures. Each sub-unit has a defined ___iii____ (or sequence), which dictates some regular patterns in the amino acid chain or ___iv___.

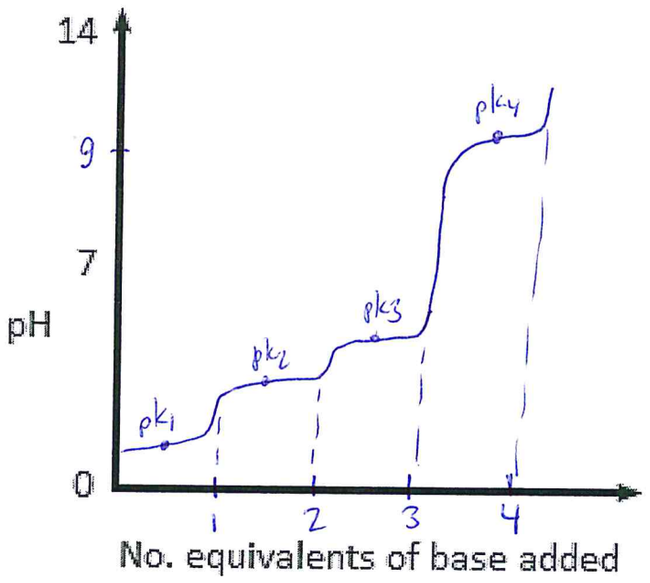


A) i: primary, ii: secondary, iii: tertiary, iv: quaternary.
B) i: tertiary, ii: secondary, iii: primary, iv: quaternary.
C) i: quaternary, ii: tertiary, iii: primary, iv: secondary.
D) i: secondary, ii: tertiary, iii: primary, iv: quaternary.
E) i: quaternary, ii: tertiary, iii: secondary, iv: primary.

37. Nopaline is a rare amino acid derived from glutamic adic and arginine. It has 4 pK_a values.



If you were to titrate nopaline with NaOH, draw the approximate titration curve that would be obtained on the graph below. Be sure to indicate the number of equivalents on the x axis.

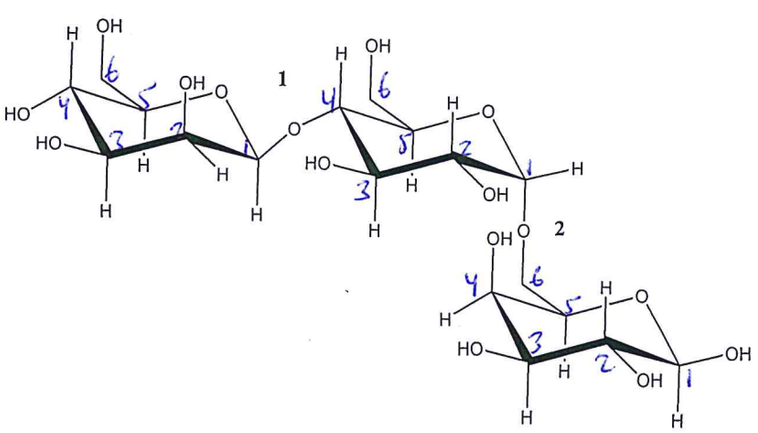


It has 3 carboxyls so the 3 first pk's are low (2-4) and the fourth is closer to 9 (amino group).

38. The trisaccharide below is made of mannose, glucose and galactose (from left to right).
a) Number all carbon atoms on the structure and describe glycosidic bonds 1 and 2 in terms of anomericity and position.

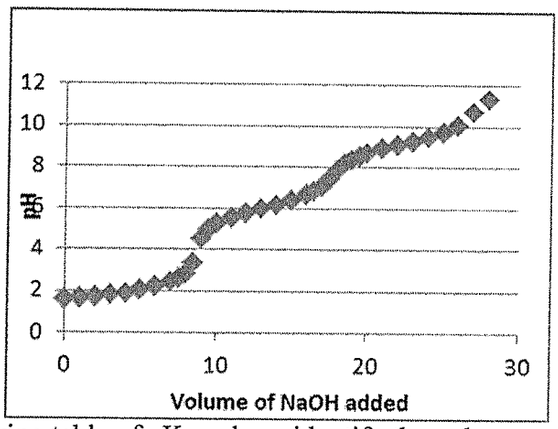
1) β 1-4
2) α 1-6

b) As represented, in terms of isomerism mannose and glucose are epimers and anomers.



E) y-axis: absorbance, x-axis: [BA]

43. A titration curve for an unknown amino acid is depicted below.



Based upon the following table of pKa values, identify the unknown amino acid.

Amino acid	**pKa Values**		
	carboxyl	amino	R-group
Histidine	1.9	9.2	6.0
Proline	2.1	10.6	
Asparagine	2.0	8.8	
Alanine	2.2	9.8	
Glutamic acid	2.2	9.7	4.3

A) Histidine
B) Proline
C) Asparagine
D) Alanine
E) Glutamic acid

44. Which of the following statements about the Bradford Assay is true?
A) It was developed during the 1960s.
B) The assay is based upon the dye 4-nitroaniline.
C) The dye CBB has three different colored forms.
D) When protein is added to the Bradford Reagent the absorbance value at 466 nm increases.
E) None of the above.

45. The catalytic rate for hydrolysis of substrate BA by trypsin was found to be 0.840 absorbance units/minute. If the total volume of enzyme and substrate in the cuvette was 3.00 mL and the absorption coefficient of the reaction product is 8,800 $M^{-1}cm^{-1}$, what is the reaction rate in units of M/minute if the path length is 1 cm?

A) The concentration and volume of enzyme used is required to answer this question.
B) 5.1×10^{-7}
C) 9.5×10^{-5}
D) 9.5×10^{-3}
E) 0.286

$A/_{min} = 9 C/_{min}$

$0.840/_{min} = 8800 \times 1cm \times C/_{min}$

$C/_{min} = 9.5 \times 10^{-5}$ M/min

46. Which step in Experiment 5: The Effect of Storage Conditions on Banana Ripening separated the reducing sugars from the starch?

A) grinding with liquid nitrogen
B) centrifugation
C) heating of supernatant at 85 °C with DNS
D) washing the pellet with acetone
E) none of the above

47. 0.430 grams of iodine was taken up by 1.22 grams of lipid. What is the Iodine Value for this lipid?

A) 2.84
B) 28.4
C) The volume of thiosulfate used to titrate the control is required to answer this question
D) 0.19 grams
E) 35.2

0.430g → 1.22g x = 35.2
x → 100g

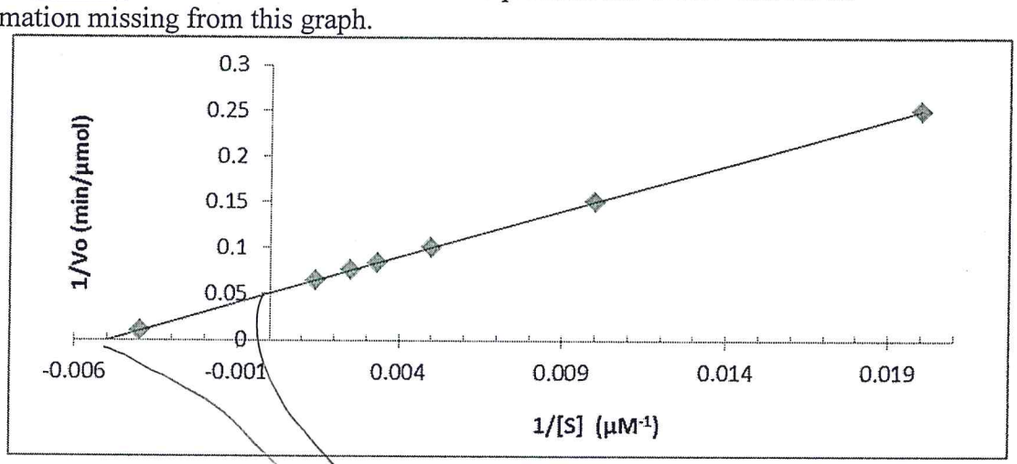
48. Single-stranded DNA absorbs more UV light than double-stranded DNA. This is known as the:

A) hypochromic effect
B) hyperchromic effect
C) salt effect
D) shielding effect
E) Bradford effect

49. The reagent that was used to distinguish glucose form starch in the Banana Experiment was:

A) BA
B) ONPG
C) CBB
D) KI
E) DNS

50. Based upon the Lineweaver-burke graph depicted below, indicate which values for K_M and V_{max} are the **nearest** to the true values for these two parameters. **Note:** there is no required information missing from this graph.



A) 200 µM and 20.0 µmol/min
B) 20.0 µM and 20.0 µmol/min
C) 200 mM and 20.0 mmol/min
D) 200 µM and 20 mmol/min
E) 200 mM and 20 µmol/min

$\frac{1}{V_{max}} = 0.05 \Rightarrow V_{max} = 20\ \mu mol/min$

$\frac{-1}{K_m} \simeq -0.005 \Rightarrow K_m = 200\ \mu M$