

See announcements on Blackboard next week for office hour announcement.

DO NOT OPEN THE EXAM UNTIL YOU ARE TOLD TO DO SO.

In the meantime, read this...

- On your Scantron card, please record the following:

Name: (your name)	Test no.: Final
Subject: Chem 105	Period: (your section–day, eve or online)
Date: 4/23/16	
- You may not leave the room before the Instructor announcement at 11:30. After that time, you may leave, but you must turn in your Scantron form before leaving the room. You will not be permitted to return to the exam room (unless you have previously made arrangements with the Instructor).
- At the end of the exam, turn in **only your Scantron form**. All answers will be recorded on the Scantron form. If you record your answers in the test booklet, you will be able to check them against the posted key this weekend. Since you're keeping the test booklet, you can take it apart and use any parts of it as scratch paper.
- You may use your calculator and a pencil. **Scantron only reads pencil** reliably. Use of other writing implements on the Scantron form may cause delays or errors in scoring.
- Be very gentle with your Scantron card. Stray marks, tears, folds, or foreign substances can easily cause correct answers to be graded as incorrect. Deliberate sabotage will result in action against the student under the University's Academic Dishonesty policies.
- No papers or objects other than your exam paper, calculator, and pencils are permitted.** All other papers and objects must be stowed out of sight. Put all notes, books, etc away and out of sight. Turn off audible and vibrate signals on all electronic devices, and put all devices other than your calculator away and out of sight. **Communications devices must be put away. Use of calculator functions on communication devices is not permitted. Sharing calculators is not permitted.**
- If you need more scratch paper, you may get it from the proctors. **You may not use your own paper.**
- Strategy hint: take a quick look over the whole exam before you start. If you see something that looks easy for you, go for it! It's good to get a few points in the bag right away.
- Strategy hints for multiple choice:
 - ▶ when you have determined that an option is not correct, mark it off so you don't have to check it again!
 - ▶ even if you think you have found the right answer, look at the remaining answers to see if any of them are a better match.

Wandering eyes will not be tolerated. Students who appear to have trouble keeping their eyes on their own paper will be moved to a more appropriate location.

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Periodic Table of the Elements

1A		2A												3A	4A	5A	6A	7A	8A
1 H 1.008																		1 H 1.008	2 He 4.003
3 Li 6.941	4 Be 9.012												5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00		9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31												13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06		17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.41	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80		
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc [98]	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3		
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po [209]	85 At [210]	86 Rn [222]		
87 Fr [223]	88 Ra [226]	89 Ac [227]	104 Rf [261]	105 Db [262]	106 Sg [266]	107 Bh [264]	108 Hs [277]	109 Mt [268]	110 Ds [281]	111 Rg [272]	112 [285]	113 [284]	114 [289]	115 [288]	116 [292]				

Lanthanides	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm [145]	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np [237]	94 Pu [244]	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]	103 Lr [262]

Potentially useful information:

$$[\text{H}^+] \times [\text{OH}^-] = 1.0 \times 10^{-14}$$

$$\text{pH} = -\log[\text{H}^+]$$

$$[\text{H}^+] = 10^{-\text{pH}}$$

$$1 \text{ mol} = 6.022 \times 10^{23}$$

Strong acids: HCl

HNO₃

H₂SO₄

$$1\% \text{ w/v} = 1\text{g}/100 \text{ mL} = 1 \text{ g/dL}$$

$$1 \text{ ppm} = 1 \mu\text{g}/\text{mL}$$

$$1 \text{ ppb} = 1 \text{ ng}/\text{mL}$$

$$\text{Dilution: } C_1 \times V_1 = C_2 \times V_2$$

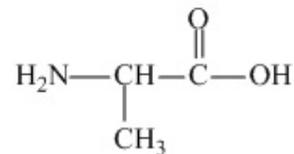
$$\text{equivalents} = \text{moles} \times \text{charge}$$

Part I. True/False and Multiple Choice, 1 point each. Record your answers on the Scantron card.

A. Decide whether each of the following statements is (A) TRUE or (B) FALSE.

A TRUE B FALSE

- 1 CH₄ is a tetraprotic acid,
- 2 To predict the solubility of organic compounds in water, we compare the hydrophobic and hydrophilic areas.
- 3 Solutions with greater [H⁺] have lower pH values.
- 4 The molecule to the right is a fatty acid.
- 5 O₂ is both an element and a compound.
- 6 HCl is an ionic compound.
- 7 Soluble ionic compounds are called electrolytes because their solutions conduct electricity.
- 8 Polysaccharides contain alcohol and ether functional groups.
- 9 Alcohols can be oxidized to form carbonyl groups.
- 10 The reverse of an endothermic process must be exothermic.
- 11 In CO₂, the C atoms have a +4 charge.
- 12 The name "lipase" indicates an enzyme.
- 13 Triglycerides are formed by condensation reactions between monosaccharides.
- 14 Triglycerides are hydrophilic.
- 15 A single S atom has a mass of 32.06 amu.
- 16 If two atoms are isotopes of each other, they will have the same number of neutrons.
- 17 In an acid-base neutralization reaction, the acid donates an H atom to the base.

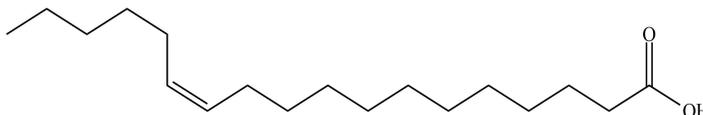


B. Assign each of the following as (A) SOLUBLE in water or (B) INSOLUBLE in water. (In each case, think about the kind of substance and what factors go into making it soluble or insoluble. Drawing structures or writing formulas may help.)

A SOLUBLE

B INSOLUBLE

- | | |
|------------------------|---|
| 18 propanoic acid | 21 sodium carbonate |
| 19 3,3-diethylpentane | 22 ammonia |
| 20 iron(III) hydroxide | 23 the substance represented by this structure: |



Part I continued (1 point each).

C. Assign each of the following aqueous solutions as (A) acidic, (B) basic or (C) neutral. (In each case, think about the kind of substance and what factors go into making it act as an acid, a base, or neither.)

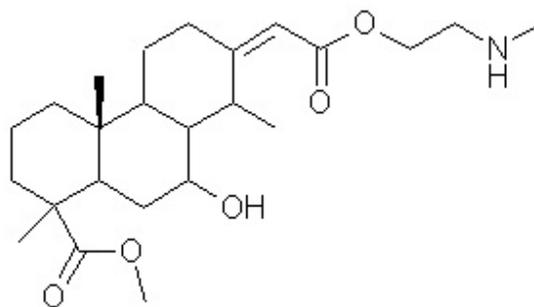
- | | | |
|--|--|------------------|
| <p>A ACIDIC</p> <p>24 A solution with pH 10</p> <p>25 A solution with $[H^+] = 2.0 \times 10^{-9}$ M</p> <p>26 A solution of 0.1 M HF</p> | <p>B BASIC</p> <p>27 A solution of CO_2 (aq)</p> <p>28 A solution of 0.1 M ammonia</p> <p>29 A solution with $[OH^-] = 1.0 \times 10^{-7}$ M</p> | <p>C NEUTRAL</p> |
|--|--|------------------|

D. For each of the following pure substances at room temperature, state whether it will be (A) solid, (B) liquid or (C) gas. (Again, in each case, think about the kind of substance and what the factors are that decide its state at room temperature. Drawing structures or writing formulas may help.)

- | | | |
|---|---|--------------|
| <p>A SOLID</p> <p>30 2-butene</p> <p>31 a polysaccharide</p> <p>32 phenol</p> | <p>B LIQUID</p> <p>33 cyclohexane</p> <p>34 nitric oxide</p> <p>35 sodium phosphate</p> | <p>C GAS</p> |
|---|---|--------------|

E. The following items refer to the molecule shown. For each functional group, mark (A) if the functional group is present, (B) if it is not. (Hint: circle and label the functional groups in the structure first, then answer for each of the functional groups listed.)

- | | |
|---|---|
| <p>A PRESENT</p> <p>36 1° (primary) alcohol</p> <p>37 2° (secondary) alcohol</p> <p>38 3° (tertiary) alcohol</p> <p>39 aldehyde</p> <p>40 alkene</p> <p>41 alkyne</p> <p>42 amide</p> <p>43 amine</p> | <p>B NOT PRESENT</p> <p>44 aromatic group</p> <p>45 carboxylic acid</p> <p>46 ester</p> <p>47 ether</p> <p>48 ketone</p> <p>49 phenol</p> <p>50 thiol</p> |
|---|---|



Turn your Scantron card over. You will start the next multiple choice section on #51.

Part II. In the green space on the back of your Scantron card, draw a simple sketch of the hydrogen-bonding interaction between a molecule of **propanoic acid** and a molecule of **water**. (If you don't know what **propanoic acid** is, draw something that can have a hydrogen bonding interaction for partial credit.) *7 points: 3 points for propanoic acid structure, 4 points for hydrogen bonding interaction.*

Don't put your answer here. Put it in the green space on your Scantron.

Part III. Multiple choice (3 points each). **Check the problem numbers carefully and record your answers on the back of the scantron card!**

51 Radiation dosages can be measured in unit called Sieverts (Sv). A typical person receives about 0.75 mSv per year from medical radiation (e.g., X-rays). How much is this dose in Sv?

- A 0.00075 Sv B 0.075 Sv C 0.75 Sv
D 750 Sv E 750,000 Sv

52 Which object below has mass closest to **one gram**?

- A a human nerve cell B the eraser on a standard wooden #2 pencil C a horse
D your Chemistry textbook E a typical computer mouse

53 A certain ion has 20 protons, 21 neutrons and 18 electrons. What is its **mass number**?

- A 18 B 20 C 21 D 40.08 E 41

54 A certain ion has 12 protons, 13 neutrons and 10 electrons. What is its **charge**?

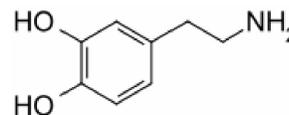
- A -2 B 0 C +2 D 18 E 20

55 What happens to CaCl_2 when it dissolves in water?

- A CaCl_2 molecules are surrounded by water molecules in solution.
B Ca atoms and Cl_2 molecules are surrounded by water molecules in solution.
C Ca atoms and Cl atoms are surrounded by water molecules in solution.
D Ca^{2+} ions and Cl^- ions are surrounded by water molecules in solution.
E Nothing, CaCl_2 is not soluble in water.

56 How many carbon atoms are there in a molecule of **dopamine**?

- A 6 B 7 C 8 D 9 E 10



dopamine

57 A certain element is a solid at room temperature. It forms monatomic ions with a charge of +1 (and does not form ions of any other charge). To which group does this element likely belong?

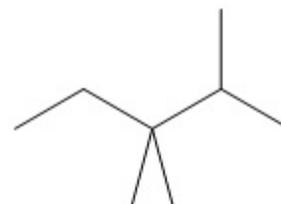
- A noble gases B alkali metals C alkaline earth metals
D halogens E transition metals

58 What is the formula of the compound **copper(II) phosphide**?

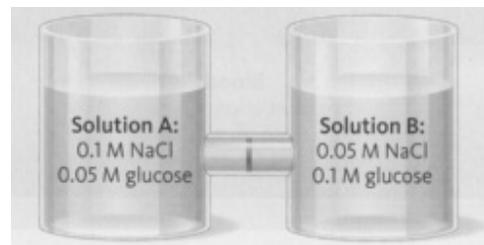
- A CuP B Cu_2P C Cu_2P_3 D Cu_3P_2 E $\text{Cu}_3(\text{PO}_4)$

59 What is the correct, systematic name for the compound represented in the line structure shown?

- A 2-ethyl-3-methylpentane B 3-ethyl-2-methylpentane
C 2,3,3-trimethylpentane D 2-methyl-2-dimethylpentane
E isooctane



60 In the diagram to the right, solutions A and B are separated by a membrane that is **permeable to molecular compounds, but not ions**. Solution A contains 0.10 M NaCl and 0.05 M glucose; Solution B contains 0.05 M NaCl and 0.10 M glucose. Which of the following statements is **true**? (Hint: analyze and mark whether each statement is true or false.)



- A Initially, both solutions have the same total solute concentration.
- B Initially, there is no net flow of water.
- C Sodium chloride dialyzes from Solution A to Solution B.
- D Glucose dialyzes from Solution A to Solution B.
- E Over time, the volume of Solution A will increase and the volume of Solution B will decrease.

61 Blood plasma has a total solute concentration of about 0.28 M. What will happen to a blood cell that is placed in a 0.28 M solution of glucose ($C_6H_{12}O_6$) ?

- A crenation (the cell will shrivel)
- B hemolysis (the cell will swell and burst)
- C the cell will become more basic
- D the cell will become more acidic
- E nothing; the solution is isotonic

62 Calculate the $[OH^-]$ of a solution with $[H^+] = 0.02$ M.

- A 5×10^{-13} M
- B 0.02 M
- C 0.95 M
- D 1.0 M
- E 1.7 M

63 Which of the following solutions has the **lowest pH**?

- A 1.0 M CH_3COOH
- B 0.01 M CH_3COOH
- C 1.0 M HCl
- D 0.01 M HCl

64 Which of the following reactions converts **ethanol** into **ethene**?

- A oxidation
- B precipitation
- C dehydration
- D condensation
- E hydrogenation

65 Which of the reaction equations below represents an acid-base neutralization?

- A $HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$
- B $H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq)$
- C $H_2CO_3(aq) \rightleftharpoons H^+(aq) + HCO_3^-(aq)$
- D $2 H_2O(g) \rightarrow 2 H_2(g) + O_2(g)$
- E $NH_3(aq) + HC_2H_3O_2(aq) \rightleftharpoons NH_4^+(aq) + C_2H_3O_2^-(aq)$

66 Which of the following is NOT an isomer of cyclopentane?

- A pentane
- B cis-2-pentene
- C 2-methyl-1-butene
- D methylcyclobutane
- E 1,2-dimethylcyclopropane

67 Write the equation for the **combustion of C_5H_{10}** , balanced with lowest possible whole-number coefficients. What is the coefficient of water?

- A 5
- B 7
- C 10
- D 15
- E 20

68 Which of the following aqueous chemical species is a **diprotic acid**?

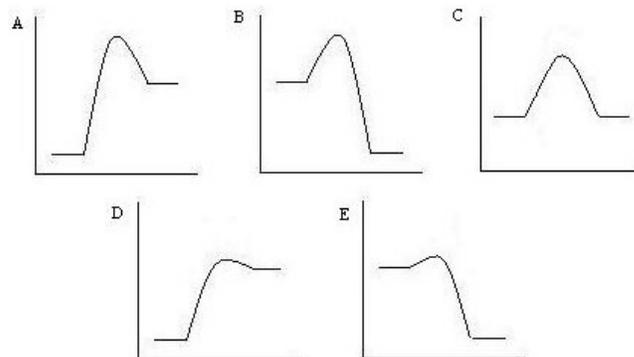
- A H_2
- B H_2O
- C $H_2AsO_4^-$
- D SO_4^{2-}
- E $Ba(OH)_2$



Iron metal reacts exothermically with sulfuric acid according to the reaction above. Which of the following changes to the conditions of a reaction would make the reaction **slower**?

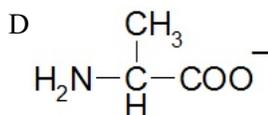
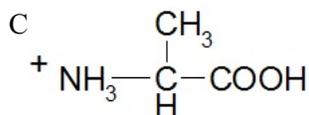
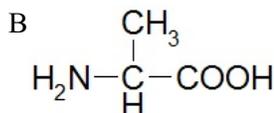
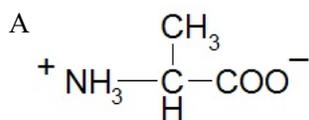
- A cooling the reaction mixture B adding more H_2SO_4
 C adding more $\text{H}_2 \text{ (g)}$ D grinding the Fe (s) into small pieces before adding it
 E adding an appropriate catalyst

70 A certain reaction is **exothermic** and has a **high activation energy**. Which graph best represents this reaction? (Assume the y-axis scale is the same on all 5 graphs.)



71 Which graph represents the same reaction as in #70, after the addition of a catalyst for the reaction?

72 Below are four possible forms of the amino acid alanine. Which structure shows how alanine would appear under basic conditions?



73 Calculate the molar mass of disulfur hexachloride. (Hint: first write the formula.)

- A 30.01 B 67.5 C 122.6 D 184.4 E 276.8

74 When you write the value for the molar mass of a substance (as in the previous question), what unit(s) should be included with your number?

- A mol B amu C mol/g D g/mol E mol/L

75 Skim milk contains 12 g of sugar in each 240-mL serving. What is this concentration, expressed as % (w/v)? (Given: % w/v = g solute/100 mL solution.)

- A 0.050 % B 2.9 % C 5.0 % D 12 % E 22 %

76 A researcher needs to prepare one liter of 2.7 % (w/v) NaCl solution. The stock solution is 25 % (w/v) NaCl. How much of the stock solution is needed (in mL)? (Please keep track of units carefully.)

- A 0.0675 mL B 0.108 mL C 0.675 mL
 D 10.8 mL E 108 mL

77 If the pH of your blood starts to become too **low**, what physiological response can help your body to compensate?

- A Holding the breath to retain more carbon dioxide
- B Breathing more slowly to take in less oxygen
- C Breathing more rapidly to expel more carbon dioxide
- D Increasing muscle activity to produce more lactic acid
- E Excreting more water in the urine to make the blood more concentrated

78 Which species is the **conjugate base** of HS^- ?

- A H_2S
- B HS^-
- C S^{2-}
- D HSO_4^-
- E H_2SO_4

79 Human blood has a pH of approximately 7.4, while tomato juice has a pH of approximately 4.4. Which statement correctly compares the acidity of these two fluids?

- A Tomato juice is about 60% as acidic as blood.
- B Tomato juice is twice as acidic as blood.
- C Tomato juice is about ten times as acidic as blood.
- D Tomato juice is about thirty times as acidic as blood.
- E Tomato juice is about 1000 times as acidic as blood.

80 In the compound N_2O , what is the charge on each N atom? Choose the **best** answer.

- A -3
- B δ^-
- C δ^+
- D +1
- E +2

81 Which substance would be the **least soluble in water**?

- A C_2H_6
- B CH_3OH
- C $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$
- D $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$

82 Which of the following substances would have the **lowest boiling point**?

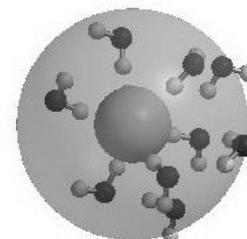
- A C_2H_6
- B CH_3OH
- C $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$
- D $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$

83 What is the normal, neutral bonding pattern for an oxygen atom?

	<u># bonds</u>	<u># lone pairs</u>
A	1	0
B	1	3
C	2	2
D	3	1
E	4	0

84 Which of the following is a reasonable identity for the species in aqueous solution represented by the picture to the right? (The V-shaped structures represent water molecules.)

- A ammonia molecule
- B fluoride ion
- C sodium ion
- D carbonate ion
- E methane molecule



Use the structures **A-D** at the side of the page to answer the next few questions.

In all cases, you may use the letter corresponding to the correct structure, or you may answer **E** for "more than one of these."

85 Which molecule contains a **phenol** functional group?

86 Which molecule contains an **ether** functional group?

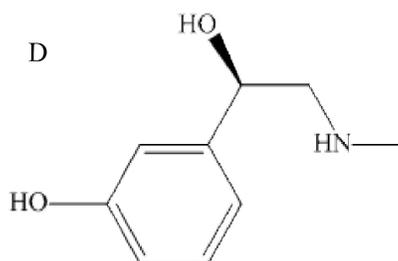
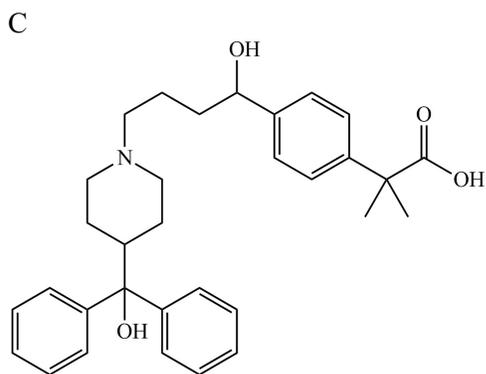
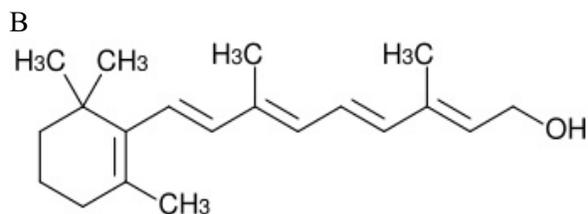
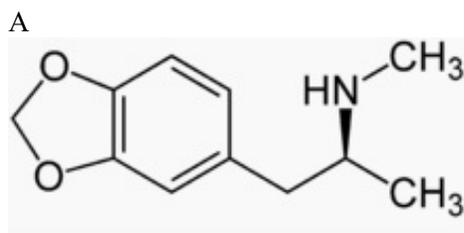
87 Which molecule includes a **primary alcohol**?

88 Which substance is subject to **hydration**?

89 Which compound's molecular formula has exactly 11 carbon atoms?

90 Which substance contains a **carbonyl** group?

Remember that in each question on this page, "**E. More than one of these**" is also an option.



Multiple Choice, Continued.

91 As an animal digests food containing large biomolecules, enzymes in the gut break down the large molecules (such as polysaccharides and polypeptides) into smaller molecules, so they can be absorbed by the body. What is the best term for this type of reaction?

- A condensation B hydrolysis C precipitation D hydration E dissociation

92 In the **hydrogenation of an alkene**, what product is formed? (Hint: sketch the reaction!)

- A a primary alcohol B a secondary alcohol C a ketone
D a carboxylic acid E an alkane

The next group of questions will use the following list of biomolecules. In each case, choose the **best** answer.

- A proteins B lipids
C mono- and di-saccharides D polysaccharides

93 These substances are the most consistently hydrophobic group.

94 Structural tissues in plants are made up of these substances.

95 These molecules are made up of long-chain carboxylic acids attached to a glycerol residue.

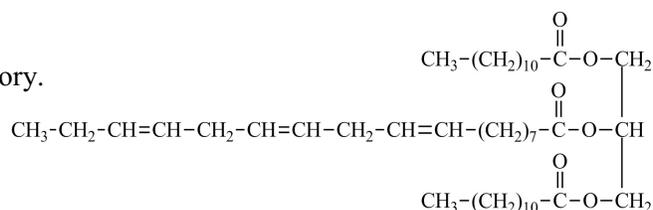
96 These molecules contain peptide linkages.

97 These substances in foods can be roughly grouped into “starch-type” and “cellulose-type.”

98 Enzymes belong to this category.

99 Vegetable oil belongs in this category.

100 The molecule shown at right belongs in this category.

**Before you go—please check:**

- Did you do the hydrogen-bonding sketch in Part II (before Question 51)?
- Did you record answers for all items 1-100, both on your Scantron (to turn in) and on your exam booklet to take and score against the posted key on Monday?
- Did you write your name and section (day/eve/online) on your Scantron card?

Have a terrific break! Check Blackboard for office hours next week if you want to review your exam.