

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...

- Clearly **print** and **sign** your name here: _____

- 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: 12/12/15	

- 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.
- **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

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

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

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

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

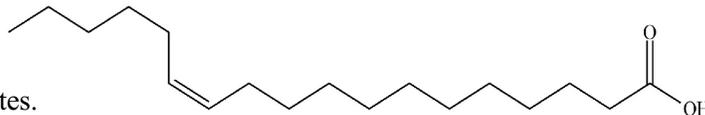
$$\text{equivalents} = \text{moles} \times \text{charge}$$

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

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

A TRUE B FALSE

- H_2PO_4^- is both diprotic and amphiprotic.
- If a molecule can form hydrogen bonds with water, the compound will always be soluble in water.
- The lower the pH of a solution, the more basic it is.
- The molecule to the right is a monosaccharide.
- Compounds that dissolve in water are called electrolytes.
- H_2 is a binary compound.
- The only functional groups in a typical triglyceride are alkenes and amides.
- H_2 is a diatomic molecule.
- “Condensation” can refer to both a physical process and a chemical reaction.
- The process of freezing liquid water to form ice is exothermic.
- SiO_2 is an ionic compound.
- The name “lipoprotein” indicates a molecule that includes both fatty acids and amino acids.
- Polypeptides are formed by condensation reactions between monosaccharides.
- “Denaturing” refers to a disruption in the primary, secondary or tertiary structure of a steroid.
- One atom of helium has a mass of 4.003 g.
- If two atoms are isotopes of each other, they will have the same mass number.
- In an acid-base neutralization reaction, the acid donates an H^+ ion to the base.

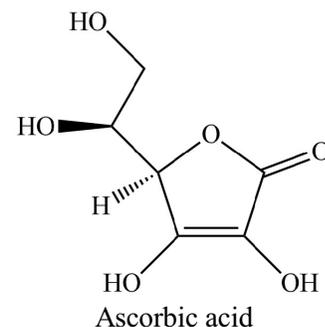


B. Assign each of the following as (A) SOLUBLE in water or (B) INSOLUBLE in water. (In each case, think about the kind of substance and what factors go into making it soluble or insoluble. Drawing structures or writing formulas may help.)

A SOLUBLE

B INSOLUBLE

- | | |
|----------------------------------|------------------------|
| 18 lead(II) sulfide | 21 a monosaccharide |
| 19 methanol | 22 potassium hexanoate |
| 20 ascorbic acid (see structure) | 23 2,3-dimethylbutane |



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.)

A ACIDIC

B BASIC

C NEUTRAL

- | | |
|--|---|
| 24 A solution with pH 0 | 27 A solution of 0.1 M CH_3OH |
| 25 A solution with $[\text{H}^+] = 1.0 \times 10^{-8}$ M | 28 A solution of 0.1 M $\text{CH}_3\text{CO}_2\text{H}$ |
| 26 A solution of 0.1 M NaOH | |

Part I continued (1 point each).

C. 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.)

A SOLID

B LIQUID

C GAS

29 methanoic acid (formic acid)

32 manganese sulfide

30 ethyne

33 3,3-diethylpentane

31 *chitin*, a polysaccharide

34 an unsaturated fat

D. The following items refer to the molecule shown at right (a drug used in some allergy medications). 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.)

A PRESENT

B NOT PRESENT

35 alcohol

42 ester

36 aldehyde

43 ether

37 ketone

44 phenol

38 amine

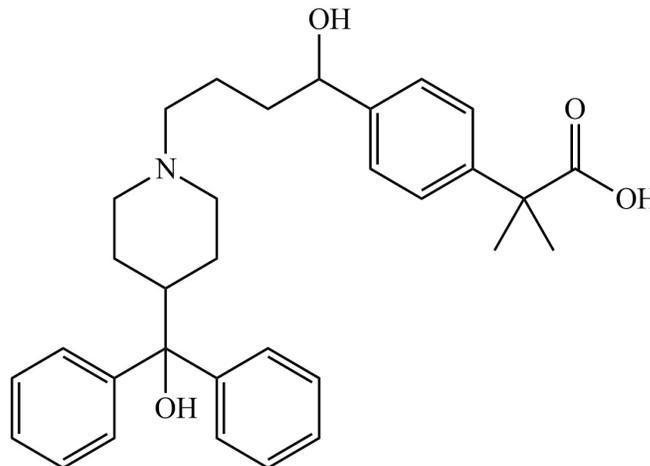
45 thiol

39 amide

46 aromatic group

40 carboxylic acid

41 cis-alkene



E. Determine whether each of the following names refers to a molecule that (A) cannot exist or violates the rules of bonding, (B) does not violate the rules of bonding but is named incorrectly, or (C) is a reasonable molecule with the correct name.

A Not possible

B Possible, but wrong name

C Possible and correctly named

47 1-methylhexane

48 4-propanal

49 hexanoic acid

50 2,2-dimethylpropane

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 **pentanal** and a molecule of **water**. (If you don't know what pentanal is, draw something that can have a hydrogen bonding interaction for partial credit.) *7 points: 3 points for pentanal structure, 4 points for hydrogen bonding interaction.*

Don't put your answer here. Put it in the space provided 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 In pregnancy tests, the concentration of hCG (a hormone produced during pregnancy) is measured in units of mIU. The concentration of hCG usually reaches 1000 mIU/mL around three weeks past conception.

Convert 1000 mIU to IU.

- A 1000 mIU = 1 IU B 1000 mIU = 1000 IU C 1000 mIU = 0.1 IU
D 1000 mIU = 0.001 IU E 1000 mIU = 0.000 001 IU

52 Which object below has a volume closest to **one deciliter**?

- 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 12 protons, 13 neutrons and 10 electrons. What is its **mass number**?

- A 10 B 12 C 13 D 24.31 E 25

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

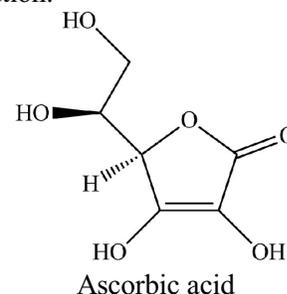
- A -2 B +2 C 10 D 12 E 25

55 What happens to NH_4NO_3 when it dissolves in water?

- A NH_4NO_3 molecules are surrounded by water molecules in solution.
B NH_4 molecules and NO_3 molecules are surrounded by water molecules in solution.
C NH_3 molecules and HNO_3 molecules are surrounded by water molecules in solution.
D NH_4^+ ions and NO_3^- ions are surrounded by water molecules in solution.
E Nothing, NH_4NO_3 is not soluble in water.

56 How many carbon atoms are there in a molecule of ascorbic acid (Vitamin C)?

- A 6 B 7 C 8 D 9 E 10



57 A certain element forms a monatomic anion with a charge of -1 (and does not form anions of any other charge). It also combines with nonmetal atoms of other elements to form molecular compounds. To which group does this element likely belong?

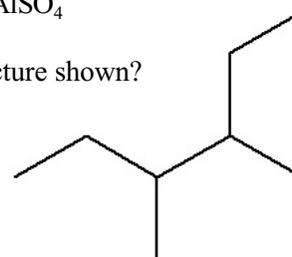
- A noble gases B alkali metals C alkaline earth metals
D halogens E transition metals

58 What is the formula of the compound **aluminum sulfate**?

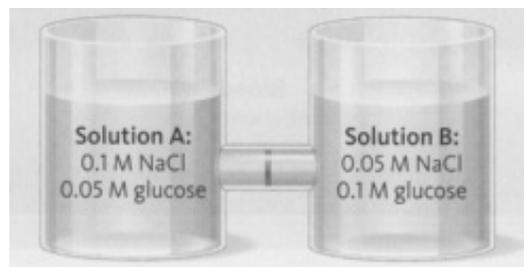
- A AlS B Al_2S_3 C Al_3S_2 D $\text{Al}_2(\text{SO}_4)_3$ E AlSO_4

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 3,4-dimethylhexane D 4-ethyl-3-methylpentane
E isooctane



60 In the diagram to the right, solutions A and B are separated by a membrane that is **permeable to water, glucose and 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 **false**? (Hint: analyze and mark whether each statement is true or false.)



- A Initially, water flows from Solution B to Solution A.
- B Glucose dialyzes from Solution B to Solution A.
- C Sodium chloride dialyzes from Solution A to Solution B.
- D Initially, the two solutions have the same total solute concentration.
- E 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 0.14 M solution of $\text{CH}_3\text{CH}_2\text{OH}$?

- 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 pH of a solution with $[\text{H}^+] = 0.02 \text{ M}$.

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

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

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

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

- A an oxidation reaction.
- B a precipitation reaction.
- C an acid-base reaction.
- D a condensation reaction.
- E a hydrogenation reaction.

65 Which of the reaction equations below represents the **dissociation of a weak acid**?

- A $\text{HCl}(\text{aq}) \rightarrow \text{H}^+(\text{aq}) + \text{Cl}^-(\text{aq})$
- B $\text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{OH}^-(\text{aq})$
- C $\text{H}_2\text{CO}_3(\text{aq}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{HCO}_3^-(\text{aq})$
- D $2 \text{H}_2\text{O}(\text{g}) \rightarrow 2 \text{H}_2(\text{g}) + \text{O}_2(\text{g})$
- E $\text{NH}_3(\text{aq}) + \text{HC}_2\text{H}_3\text{O}_2(\text{aq}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{C}_2\text{H}_3\text{O}_2^-(\text{aq})$

66 Four of the following five compounds are isomers with the formula C_5H_{10} . Which compound does NOT have this formula?

- 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 oxygen?

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

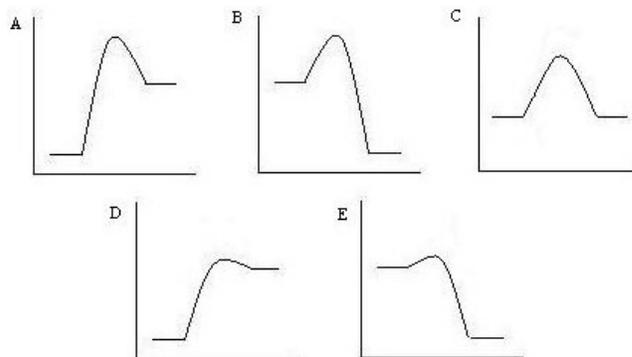
68 Which of the following aqueous chemical species is a **diprotic acid**?

- A H_2SO_3 B HSO_3^- C SO_3^{2-} D SO_2 E CH_2S

69 Which of the following changes to the conditions of a reaction would make the reaction **slower**?

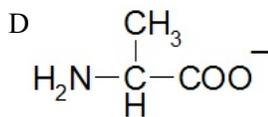
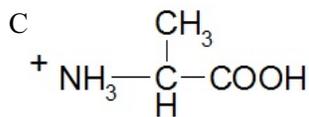
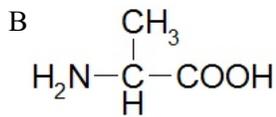
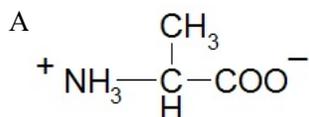
- A increasing the activation energy of the reaction B adding an appropriate catalyst
 C removing the products as they form D heating the reaction mixture
 E vigorously stirring the reaction mixture

70 Which of the graphs shown at the right represents the smallest difference in energy between **reactants and products**? (Assume the y-axis scale is the same on all 5 graphs.)



71 A certain reaction is endothermic, but has a low activation energy. Which graph best represents this reaction?

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



73 Calculate the molar mass of nitrogen dioxide. (Hint: first write the formula.)

- A 30.01 g/mol B 44.02 g/mol C 46.01 g/mol
 D 90.69 g/mol E 149.38 g/mol

74 Gatorade contains 14 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 0.058 % B 5.8 % C 14 % D 17 % E 34 %

75 Unsweetened cranberry juice has a pH of approximately 2.5, while unsweetened apple juice has a pH of approximately 3.5. Which statement correctly compares the acidity of these two juices?

- A Cranberry juice is acidic, while apple juice is basic.
 B Cranberry juice is 70% as acidic as apple juice.
 C Cranberry juice is about 1.4 times as acidic as apple juice.
 D Cranberry juice is about twice as acidic as apple juice.
 E Cranberry juice is about ten times as acidic as apple juice.

76 A bottle of vanilla syrup contains sugar at a concentration of approximately 0.6 g/mL. When one fluid ounce of this syrup is used to flavor a 16-ounce mocha, what is the final **concentration** of sugar, in g/mL?

- A 0.04 g/mL B 0.6 g/mL C 9.6 g/mL D 16 g/mL E 26.6 g/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 acid** of HS^- ?

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

79 In the compound CO_2 , what is the charge on the O atom? Choose the **best** answer.

- A -2 B -1 C δ^- D δ^+ E +2

80 Which of the following ionic compounds is soluble in water?

- A iron(II) carbonate B potassium sulfide C aluminum phosphate
D calcium phosphide E silver bromide

81 Which of the following substances would have the **highest boiling point**?

- A CH_3OH B C_2H_6 C $\text{C}_6\text{H}_{13}\text{OH}$ D C_7H_{16}

82 Which substance would have the **greatest solubility in water**?

- A CH_3OH B C_2H_6 C $\text{C}_6\text{H}_{13}\text{OH}$ D C_7H_{16}

83 What is the normal, neutral bonding pattern for a nitrogen atom?

	# bonds	# lone pairs
A	1	0
B	1	3
C	2	2
D	3	1
E	4	0

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."

84 Which compound's molecular formula has exactly 21 carbon atoms?

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

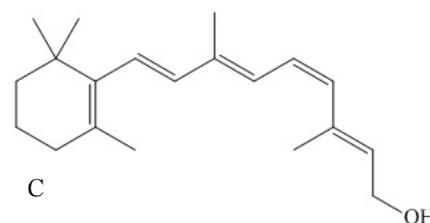
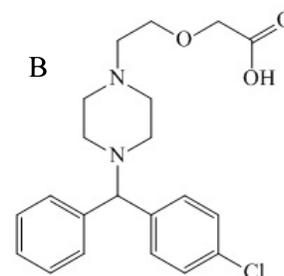
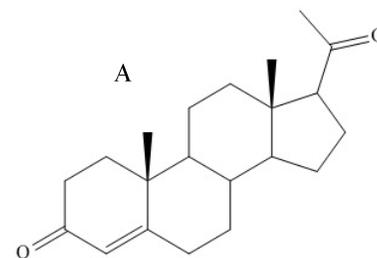
86 Which example is **not** capable of hydrogen bonding as a pure substance?

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

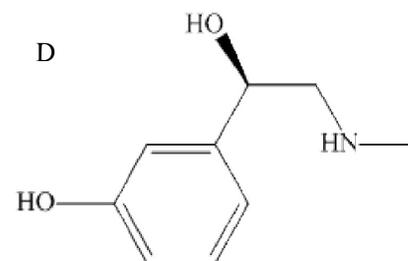
88 Which substance is subject to **hydration**?

89 Which substance is a **steroid**?

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 reduction of a **ketone** functional group with H_2 , 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
E steroids

93 These substances can be “denatured” by high temperatures, agitation, etc.

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.

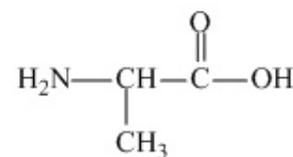
96 These molecules contain peptide linkages.

97 Vertebrate sex hormones typically are in this category.

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.