Chemistry 2030
"Introduction to Organic Chemistry"
Fall Semester 2012
Dr. Rainer Glaser

Examination #5: The Final
"Lipids, Carbohydrates, Nucleobases & DNA."

Monday, December 10, 2012, 3 – 5 pm.

Name:

Question 1. Lipids and Detergents.	20	
Question 2. Carbohydrates.	20	
Question 3. Nucleobases of DNA and RNA.	20	
Question 4. Nucleosides and Nucleotides.	20	
Question 5. Base Pairs, DNA & RNA.	20	
Total	100	

Question 1. Lipids and Detergents. (20 points)

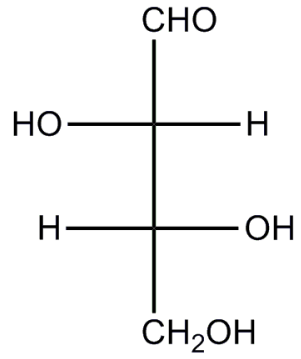
(a) Phosphatidic acids (PA) are very simple **phospholipids**. A phosphatidic acid is a derivative of glycerol that contains an inorganic ester formed with one of the primary alcohol and phosphoric acid and two organic esters formed with the remaining alcohol groups. Draw the complete structure of the phosphatidic acid formed with one stearic acid, $H_3C–(CH_2)_{\_}–COOH$ and one molecule of the unsaturated fatty acid oleic acid, $H_3C–(CH_2)_{\_}–CH=CH–(CH_2)_{\_}–COOH$. In your drawing, attach the oleic acid to one of the primary alcohols of glycerol, clearly indicate whether the alkene in oleic acid is cis or trans, and show the phosphate fully deprotonated. Finally, circle the polar region of the phospholipid. (12 points)

(b) A phospholipid usually is drawn as a circle (the polar head group) with ____ (one, two, three) wiggly line(s) signifying the nonpolar alkyl chain(s). Schematically draw a piece of a lipid bilayer and show at least 10 phospholipids. (4 points)

(c) Normal soap contains sodium or potassium carboxylates of fatty acids. A carboxylate is schematically drawn as a circle (the polar head-group) and one wiggly line (the alkyl chain). Schematically draw a micelle and show at least 15 soap molecules. Indicate where we would find the associated cations (i.e., sodium cations; draw a few in the scheme). (4 points)

Question 2. Carbohydrates. (20 points)

(a) The structure is shown of **D-threose**. Draw a perspective drawing of D-threose in the conformation used in the Fischer Projection. Draw a Newman projection of a reasonable conformation of D-threose. Assign priorities and determine the configurations a C2 and C3. (14 points)

Fischer Projection of D-threose	Convert Fischer Projection into Perspective Drawing	Newman Projection of a Reasonable Conformation
		

The **C2 carbon** in D-threose ____ (*S*, *R*). Highest priority substituent: _____ Lowest priority substituent: _____ "List" of the carbonyl-C: C(_ _ _) Prio.: ___ "List" of the other C: C(_ _ _) Prio.: ___	The **C3 carbon** in D-threose ____ (*S*, *R*). Highest priority substituent: _____ Lowest priority substituent: _____ "List" of the CH_2OH-C: C(_ _ _) Prio.: ___ "List" of the other C: C(_ _ _) Prio.: ___

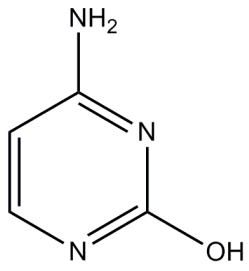
(b) Draw the Fischer projection of **D-fructose**. The molecular formula of fructose is C_H_O_. Fructose is a _____ (aldose, ketose). (6 points)

Question 3. Nucleobases of DNA and RNA. (20 points)

(a) Nucleobases. Mark each box with "yes" or "no" and, for the last row, provide the single-letter abbreviation of the complementary base in the Watson-Crick base-pair. (14 points)

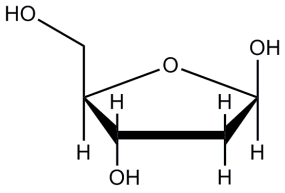
	Cytosine	**Thymine**	**Adenine**	**Guanine**
Occurs in DNA:				
Occurs in RNA:				
Is a Purine Derivative:				
Is a Pyrimidine Derivative:				
Contains an Amino (NH_2) Group:				
Contains an Imidazole:				
Contains a Cyclic Amide:				
Contains a Carbonyl Group:				
Base-Pairs with:				

(b) Tautomers of Nucleobases. Cytosine is a tautomer of 2-hydroxy-4-aminopyrimidine, and the structure of 2-hydroxy-4-aminopyrimidine itself is shown. Draw two more possible tautomers. Make sure to include the tautomer that occurs in DNA (and RNA) and circle that tautomer. (6 points)



Question 4. Nucleosides and Nucleotides. (20 points)

(a) The Haworth projection is shown of **D-2-deoxyribose**. This deoxyribose is _____ (*alpha*, *beta*, *gamma*) at the _____ carbon. 2-Deoxyribose is a _____ (aldose, ketose). Deoxyribose is a _____ (triose, tetrose, pentose, hexose). (12 points)

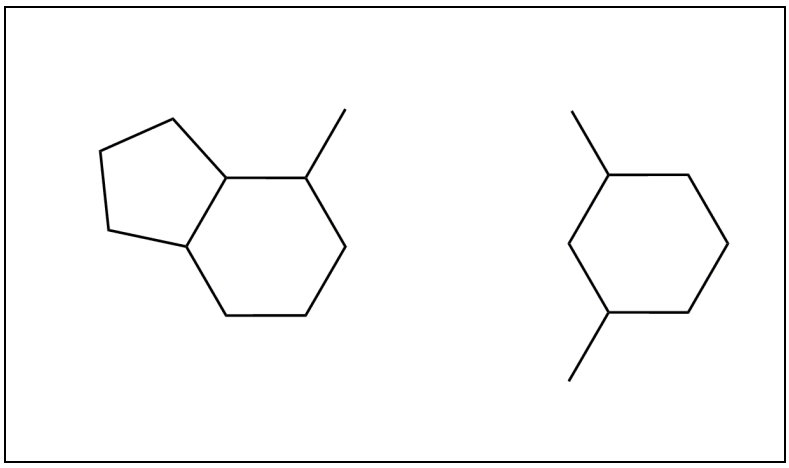
Cyclic D-2-deoxyribose	Fischer Projection of Acyclic D-2-deoxyribose	Fischer Projection of Acyclic L-2-deoxyribose	Cyclic β-L-2-deoxyribose
			

(b) Draw the Haworth projection of the **nucleoside 2'-deoxyguanosine**; i.e., draw the Haworth projection of **D-2-deoxyribose** and add the nucleobase guanine in the correct fashion. Number all C- and N-atoms in the nucleobase and the sugar. (6 points)

(c) Draw the Haworth projection of the **nucleotide 5'-monophosphate 2'-deoxyguanosine**. [The points for (c) all are given for the proper representation of the connection of the phosphate and the 2-deoxyribose.] (2 points)

Question 5. Base Pairs, DNA & RNA. (20 points)

(a) The rough skeleton of the **AU base pair** is shown. Complete the structures of **A** and **U**: add all heteroatoms and all hydrogen atoms, add two R-groups to show where the sugar moieties are attached, and add double bonds, lone pairs, formal charges, etc. Indicate hydrogen bonds as dashed lines. (12 points)



(b) Schematic depictions are shown of pieces of double-stranded DNA (left) and of a so-called stem loop of RNA (right).
(1) Indicate the repeat length of the ds-DNA (at the arrow) in nanometers.
(2) Indicate the 3'- and 5'-ends of the blue single-strand.
(3) Add the complementary nucleobases to the stem loop (i.e., add **A**, **G**, **T**, **U**, **C**).
(4) For the H-bonded base pairs in the stem loop: Add two or three solid lines between base pairs with two or three H-bonds, respectively. (8 points)