UNIVERISTY OF TORONTO
FACULTY OF APPLIED SCIENCE AND ENGINEERING
CHE 391s Organic Chemistry and Biochemistry
Final Exam - Tuesday April 17, 2001
EXAMINER: Prof. E.A. Edwards

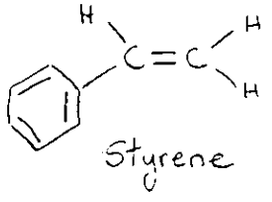
Answer all questions in the spaces provided. (14 +1 pages; 19 questions)

Name_____ Student Number:_____

Marks or Minutes | Questions:

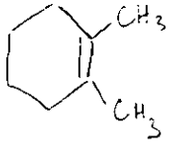
1. Predict the major (and significant minor) products of the reactions below (briefly justify your answer and name reaction type or mechanism; include stereochemistry where appropriate):

2 a)



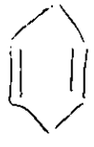
$+ HBr \xrightarrow{\text{ether}}$

2 b)



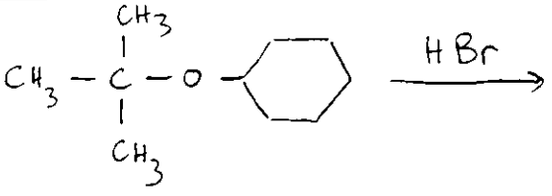
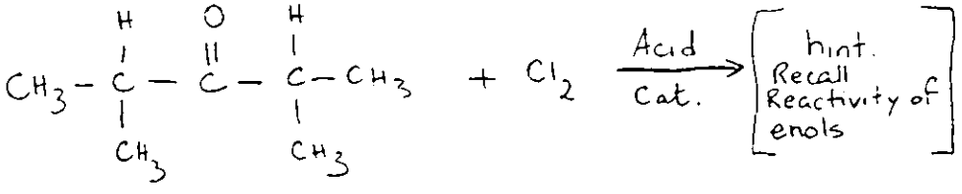
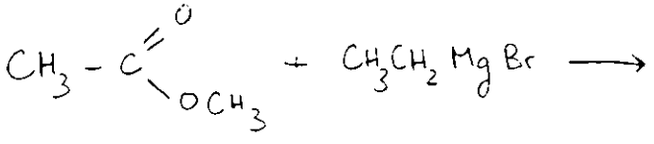
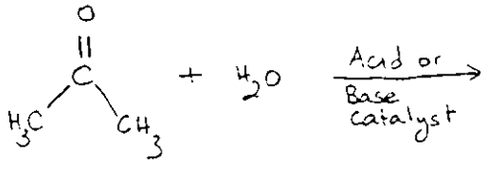
$+ H_2 \xrightarrow[\text{catalyst}]{Pd}$

2 c)



$+ KMnO_4 \xrightarrow{H_3O^+}$

2 d) $CH_3CH_2CH_2Br + NaOCH_3 \longrightarrow$

Marks or Minutes	Questions:
2	e) 
2	f) 
2	g) 
2	h) 

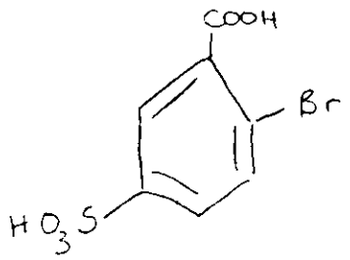
Marks or Minutes	Questions:
2	**2.** Rank the following compounds in order of increasing acidity. ? Justify your answer. a) CH_3CH_2COOH b) $BrCH_2CH_2COOH$ c) $BrCH_2COOH$
4	**3.** a) How would you prepare *p*-aminotoluene from *p*-nitrotoluene?
5	b) This reaction does not go to completion. How would you separate the amine from the un-reacted nitro coupound? (write out each step in your separation scheme)

Marks or Minutes	Questions:

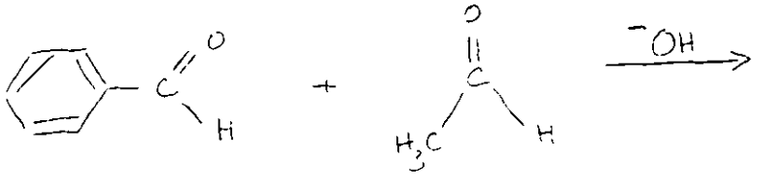
3 **4.** c) Rank these compounds in order of increasing basisity. Justify your answer.

p-chloroanaline, analine, cyclohexylamine, phenol

6 **5.** How would you synthesize the following substituted benzene from benzene (Hint: you need 4 steps)

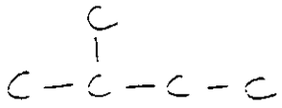


Marks or Minutes	Questions:
2	**6.** The pK_as of NH_4^+ and $CH_3NH_3^+$ are 9.30 and 10.64, respectively. Which is the stronger base, NH_3 or CH_3NH_2? Why?
3	**7.** Rank the following compounds in order of decreasing boiling points a. CH_3CH_2OH b. CH_3CH_2COOH c. $CH_3CH_2CH_3$ d. $CH_3CH_2NH_2$
6	**8.** Write the reaction mechanism for the following reaction: (show all steps). Recall - this was on your last quiz.....



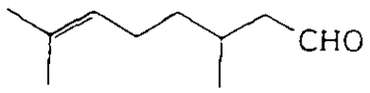
Marks or Minutes | Questions:

9. The five-carbon unit with a four carbon chain and a one carbon branch at C2 is called an isoprene unit. Compounds with a single isoprene unit (C5) are relatively rare in nature, but compounds with two such units (C10), called monoterpenes, are common.

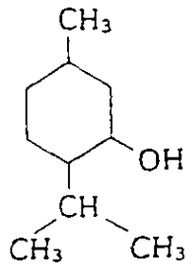


Isoprene unit

2 a) Mark off the isoprene units in citronellal and menthol. (i.e., draw a line to divide the molecules into isoprene units)



citronellal

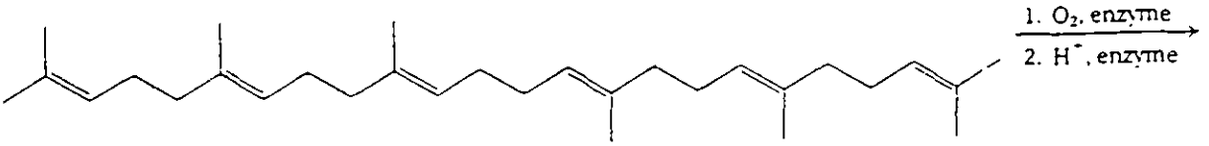


menthol

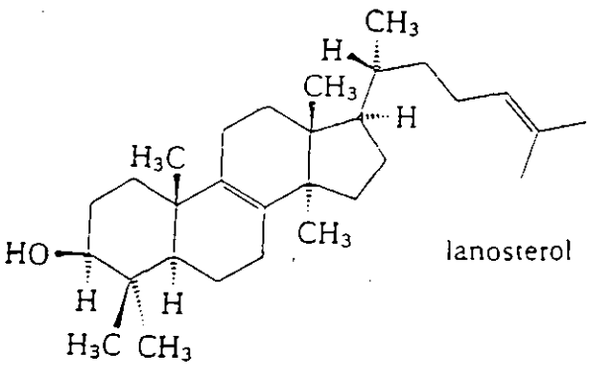
2 b) What is the principal functional group (PFG) in each of these molecules?

Marks or Minutes | Questions:

c) Steroids constitute a major class of lipids. Through a truly remarkable enzymatic reaction sequence, the acyclic triterpene squalene is converteted stereospecifically to the tetracyclic steroid lanesterol, from which other steroids are subsequently synthesized (as shown below).



squalene



lanosterol

2 b) How many carbon atoms are present in squalene? In lanesterol?

3 c) What is the configuration (Z, E) of each of the double bonds in squalene?

4 d) How many stereogenic centers are present in squalene? In lanostersol?

2 e) Name a steroid hormone.

Marks or Minutes	Questions:
	10. Consider D(+)-galactose (refer to attached table for structure).
2	a) What do the terms "D" and "(+)" mean preceding the name of the sugar?
2	b) How many stereogenic centres does D(+)-galactose have?
2	c) How many isomers of D(+)-galactose exist?
4	d) Draw the enantiomer of D(+)-galactose.
4	e) How many diastereoisomers of D(+)-galactose exist.

Marks or Minutes	Questions:

11. The Bristish carbohydrate chemist, W. N. Haworth (Nobel prize, 1937) introduced a useful way of representing the cyclic forms of sugars.

5 a) Draw the Haworth projection of the pyranose form of D(+)-mannose. Only draw the α-anomer. (use an arrow to point to the anomeric carbon)

3 b) D-Erythrose cannot exist in pyranose forms, but furanose cylic forms are possible. Explain why this is.

5 c) D-Mannitol, which occurs naturally in olives, onions, and mushrooms, can be made by $NaBH_4$ reduction of mannose. Draw its structure using a Fischer projection.

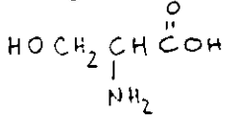
Marks or Minutes	Questions:

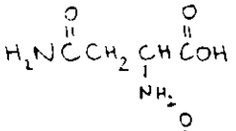
12. Cellulose is the raw material for several commercially important derivatives.

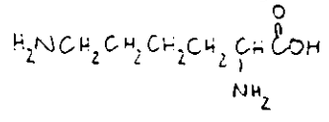
2 a) How many free hydroxyl groups are present on each glucose unit in cellulose?

4 b) These hydroxyl groups can be modified by the usual reagents that react with alcohols. What reagent would you suggest to produce cellulose acetate?

13. Consider the following three amino acids:

Serine (Ser): 

Asparagine (Asn): 

Lysine (Lys): 

3 a) Classify these three amino acids as neutral, polar, acidic or basic.

6 b) Draw the tripeptide Ser-Asn-Lys as it would be found at pH 7.

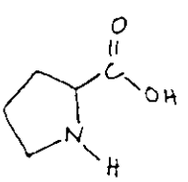
3 c) What would the overal charge of this molecule be at pH=1?

Marks or Minutes	Questions:

8 **14.** Fibrous proteins including keratins, collagens, and silks (for example skin, hair, feathers, claws, and nails, tendons, cocoons) have rigid shapes and are not water soluble. Globular proteins such as enzymes, hormones, transport proteins and storage proteins are more spherical and tend to be water soluble.

How do you think the primary, secondary and tertiary structures of these two general classes of proteins differ to account for these differences in physical properties?

3 **15.** How do you account for the fact that proline is never encountered in a protein α-helix?



proline

Marks or Minutes | Questions:

16. Styrene (shown in question 1(a)) is easily polymerized by benzoyl peroxide, and the product, polystyrene, has a molecular weight in the range of 1 to 3 million g/mole. Polystyrene is a thermoplastic polymer.

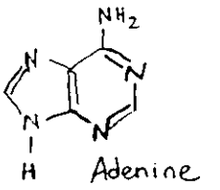
4 a. Draw three repeat units of polystyrene.

3 b) How many monomers would your typical polystyrene molecule contain?

3 c) What is meant by a thermoplastic polymer?

3 c) Polystyrene can be modified in various ways. For example, it can be made more rigid through cross-linking by including small amounts of *p*-divinylbenzene with the monomer. Show how *p*-divinylbenzene could act as a cross-linking agent.

Marks or Minutes	Questions:
6	**17.** a) What are the 3 components that form a nucleotide of DNA? Identify these components by drawing the nucleotide called 2'-deoxyadenosine monophosphate (abbreviated dAMP), where the base is adenine (drawn below).



Adenine

2	b. What does the 2' refer to?
4	c) Where and how are nucleotides linked together to form a polymer ?
5	d) Nucleotides are not only found in DNA and RNA. ATP (adenosine triphosphate) is the energy currency of a cell. ATP contains two phosphoric anhydride bonds, and considerable energy is released when ATP is hydrolyzed to ADP and further to AMP. Although we did not formally study the structure of this molecule, you should be able to deduce its structure from the information above. Draw a molecule of ATP.

Marks or Minutes	Questions:
4	**18.** The human genome contains 3 billion base pairs. Estimate the length (in cm) of DNA in a human cell. State your assumptions.
10	**19.** Which of the following statements are true and which are false? Correct false statements.

a. All amino acids are S-amino acids.

b. DNA polymerase catalyzes replication of DNA in the 3' to 5' direction

c. A disulphide bond can be important for the tertiary and quaternary structures of a protein

d. mRNA is a very unstable molecule

e. Oils contain a much higher percentage of unsaturated fatty acids than do fats.

f. The quaternary structure of proteins includes 4 sub-units.

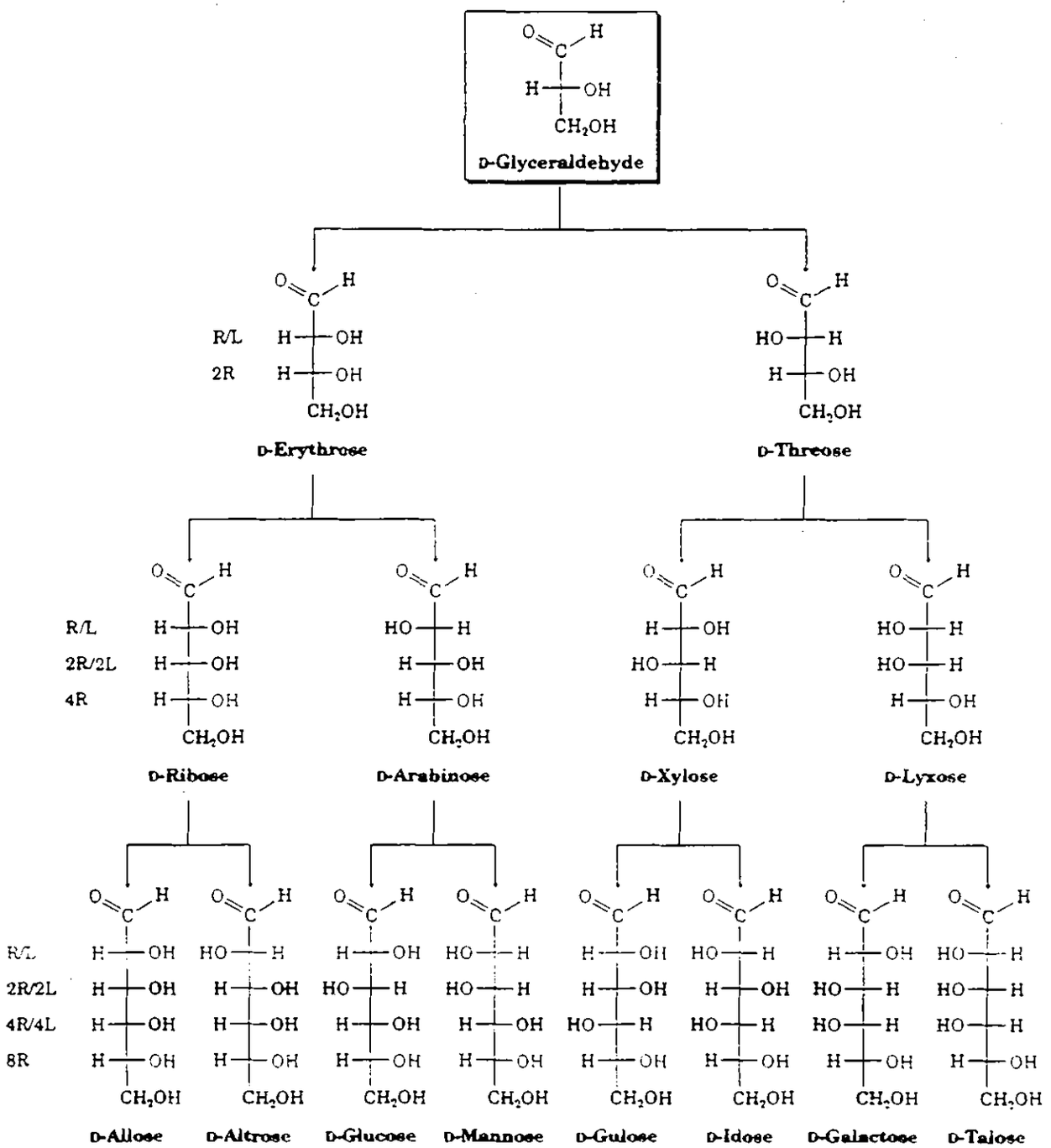
g. A β-pleated sheet is a folded tablecloth.

h. The fluid mosaic model refers to the tiles on the bottom of a swimming pool

The END

Figure 14.3

Configurations of D aldoses



2001 - CHE 391 FINAL

EXTRA INFO