Homework 6
Organic Chemistry MCAT Review
Summer 2012
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1. Fill in each blank with the word that best completes the following sentences about NMR.

The two most important isotopes for organic chemistry structure determination by NMR are _____^{1}H_____ and _____^{13}C_____. Of these two, _____^{1}H_____ is a common isotope and the predominant isotope found in molecules, while _____^{13}C_____ is relatively rare.

Nuclei with spin quantum number 1/2 are quantized in one of two orientations: _____+1/2_____ (lower energy) or _____-1/2_____ (higher energy) in the presence of an external magnetic field, that is, with and against the external field, respectively.

The difference in energy between nuclear spin states is_____proportional_____ to the strength of the magnetic field experienced by the nucleus.

Electron density is induced to move in a strong external magnetic field, and this movement induces a _____magnetic_____ field that is _____opposed_____ to the external magnetic field. This has the effect of _____shielding_____ the underlying nuclei from the external magnetic field.

All other factors being the same, the signal for an ^{1}H atom with greater electron density around it will come at _____lower_____ ppm in an NMR spectrum compared to a similar ^{1}H atom with less electron density.

The _____spins_____ of adjacent nuclei influence each other. If ^{1}H atoms are no more than _____three_____ bonds apart, the spin states couple.

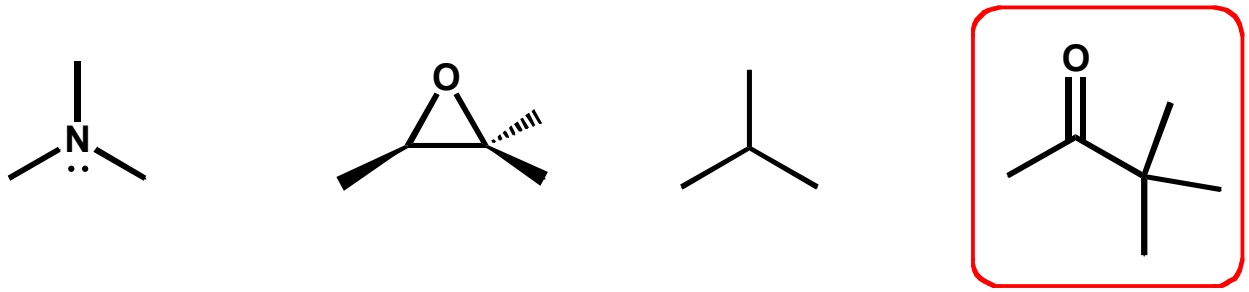
1. (cont.)

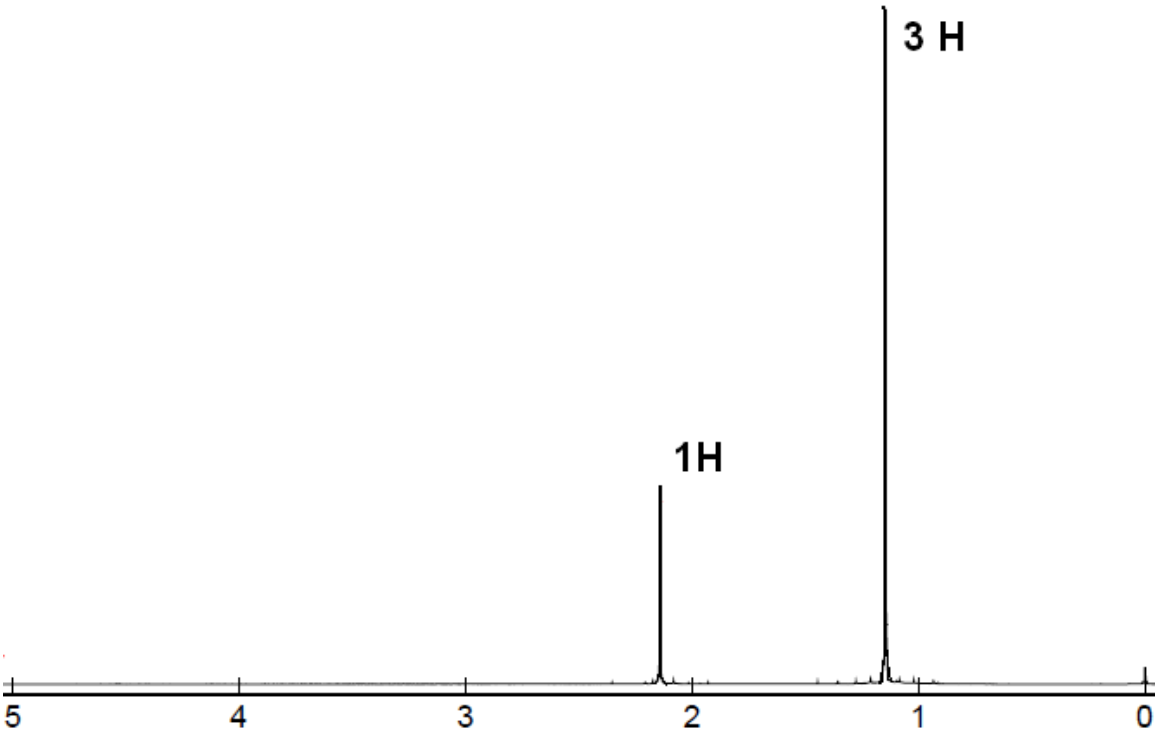
In the FT NMR method, the FT stands for _____**Fourier**_____ _____**transform**_____. The basic idea is that a short pulse using a range of radio frequencies is used to flip the spins of all of the hydrogen _____**nuclei**_____ at once. Then, the nuclear spins _____**relax**_____ back to the +1/2 spin state and when they do, they _____**emit**_____ electromagnetic radiation at the precise frequency at which they absorb.

2. Suppose a relative of yours is having an MRI. In no more than four sentences, explain to them what is happening when they have the MRI scan. There are a minumum of 7 key points here.

The popular medical diagnostic technique of **magnetic resonance imaging (MRI)** is based on the **same principles as NMR**, namely the **flipping (i.e. resonance) of nuclear spins of protons** by **radio frequency irradiation** when a patient is placed in a **strong magnetic field**. **Magnetic field gradients** are used to gain imaging information, and **rotation of the gradient around the center of the object** gives imaging in an entire plane **(i.e. slice inside patient)**. In an MRI image, you are looking at **individual slices** that **when stacked make up the three-dimensional image** of **relative amounts of protons, especially the protons from water and fat, in the different tissues**.

3. Circle the molecule that corresponds to the NMR spectrum shown below.





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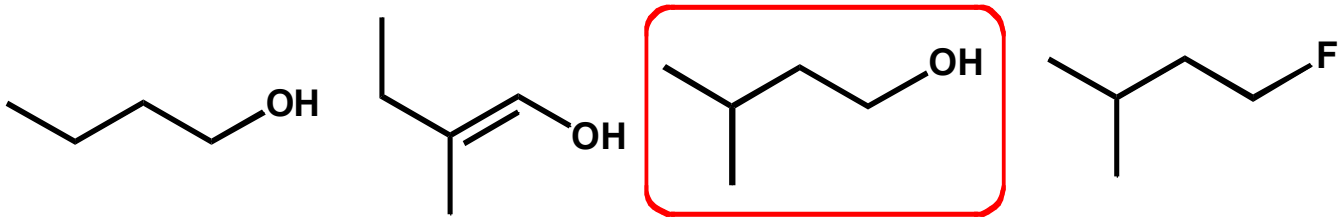

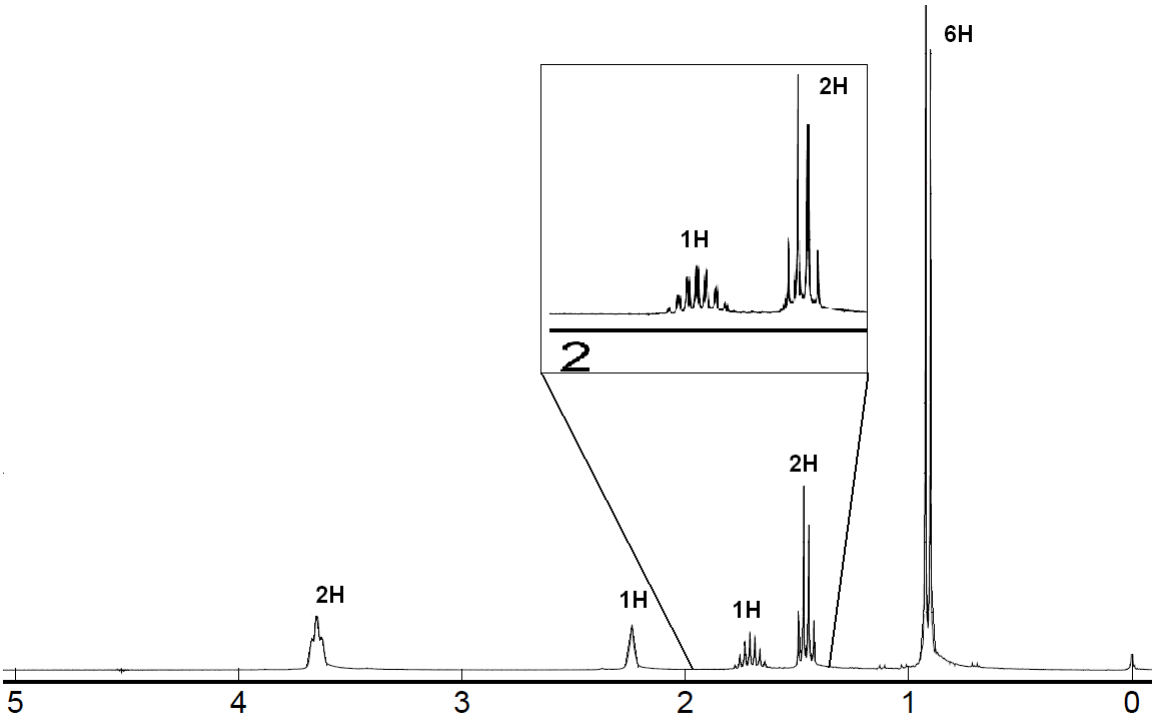

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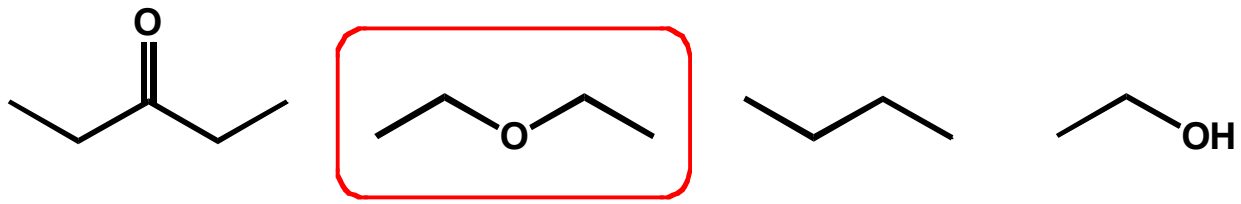

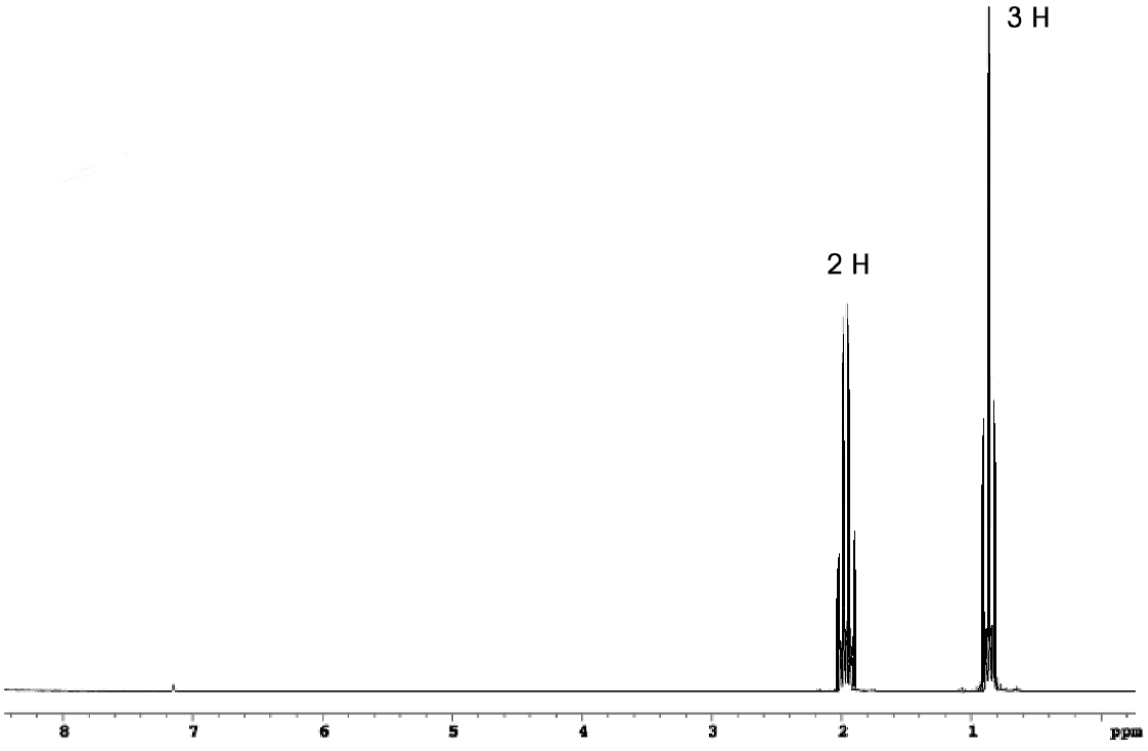

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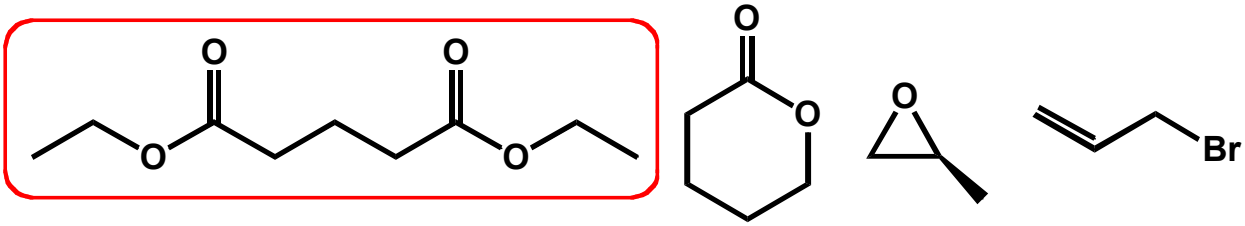
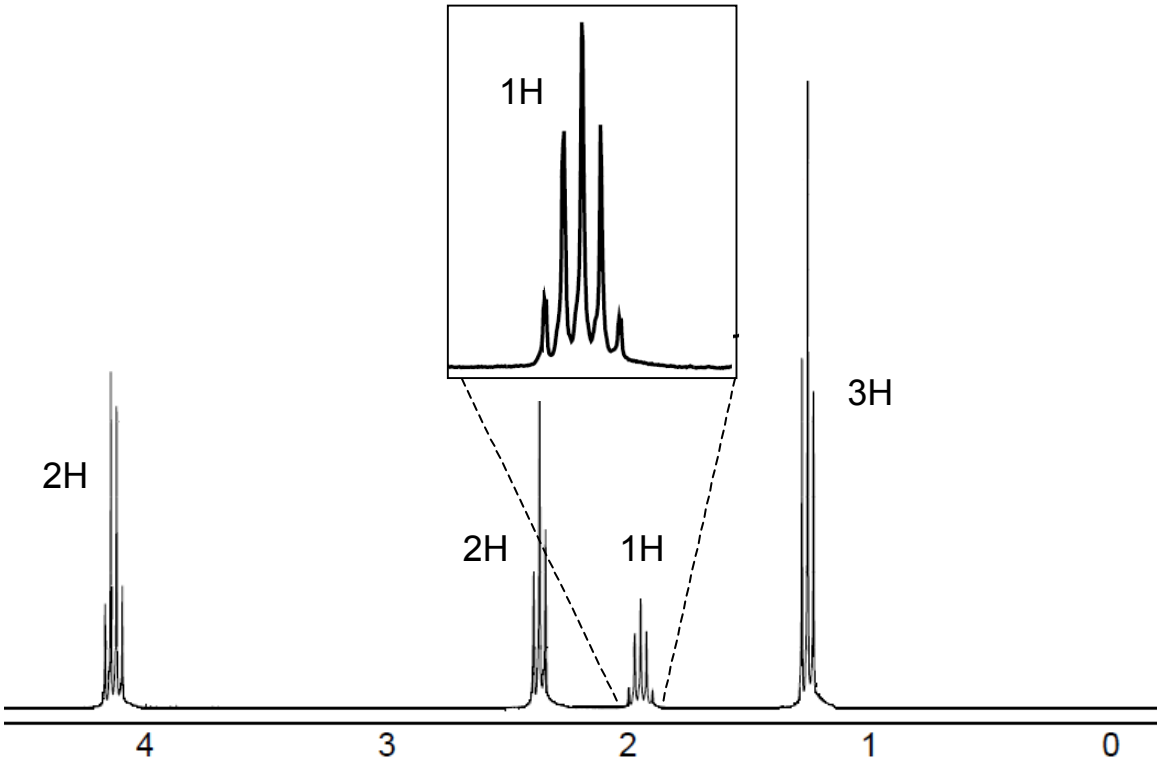
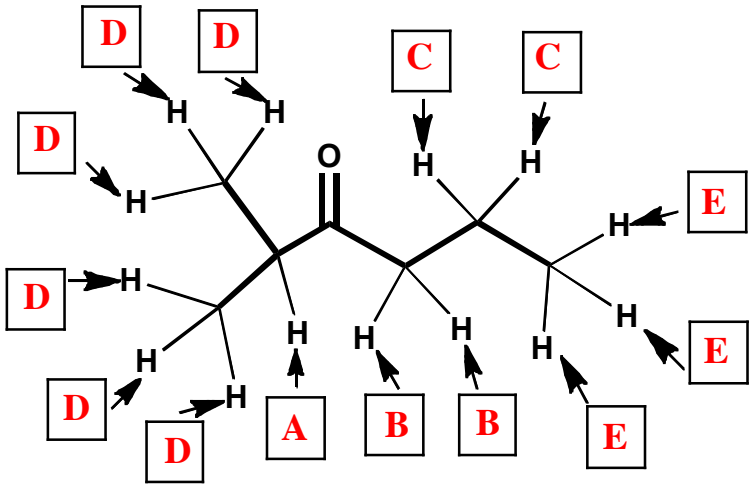
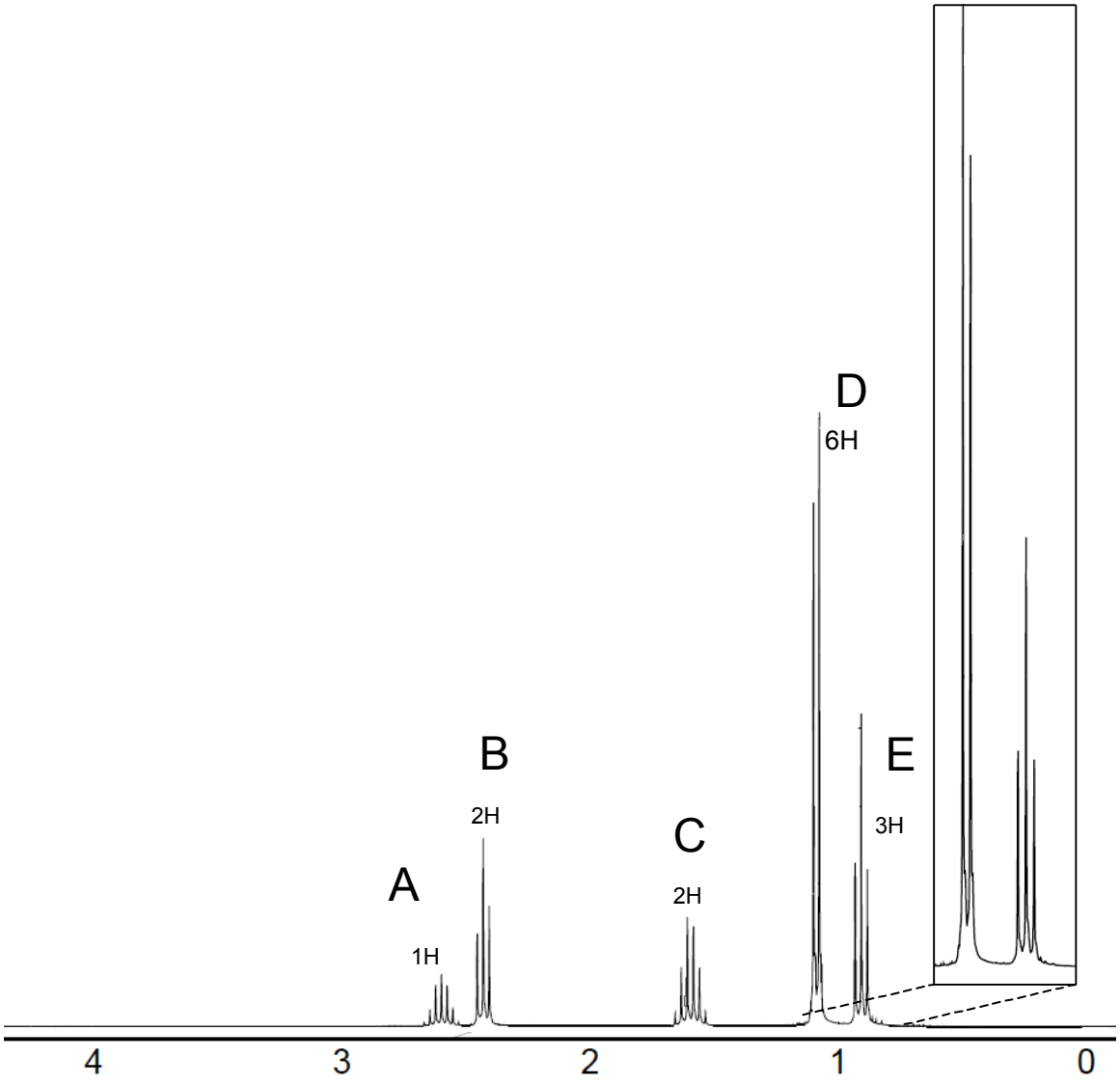


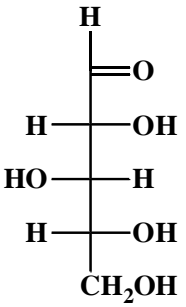


4. In the boxes provided, place that letter (A, B, C, etc.) that corresponds to the signals in the spectrum provided below.

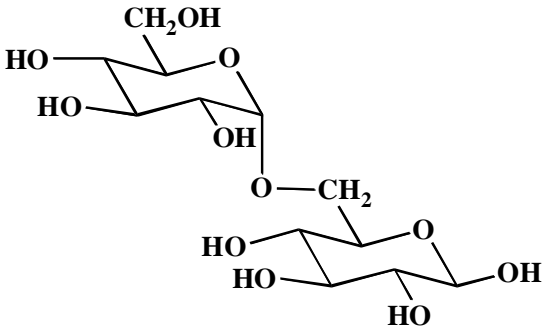




5. For the following structures, draw a circle around the terms that provide the most accurate description.

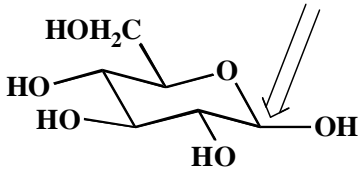


Aldohexose
Ketohexose
Aldopentose
Ketopentose
Pointy toes
Fred



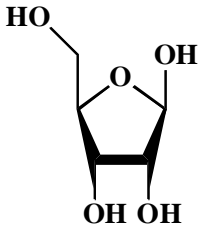
α-1,6-Glycosidic bond
β-1,6-Glycosidic bond
α-1,5-Glycosidic bond
β-1,5-Glycosidic bond
α-1,4-Glycosidic bond
β-1,4-Glycosidic bond
α-1,3-Glycosidic bond
β-1,3-Glycosidic bond
α-1,2-Glycosidic bond
β-1,2-Glycosidic bond
Fred

Monomeric carbon
Anomeric carbon
Polymeric carbon
Aldehyde carbon
Fred



This structure is a:
Furanose
Pyranose
Comatose
Bloody nose
Fred

This molecule is a:
Aldohexose
Ketohexose
Aldopentose
Ketopentose
Pointy toes
Fred



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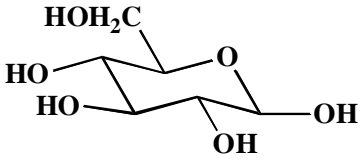
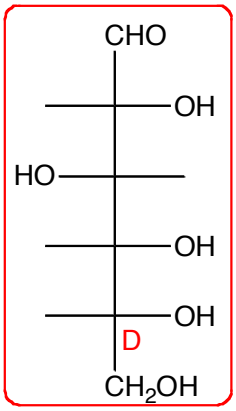
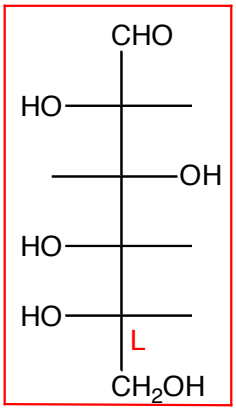
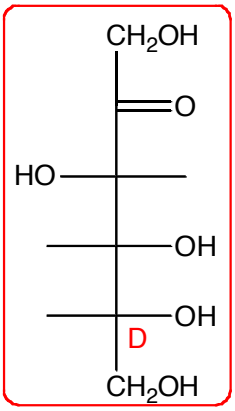


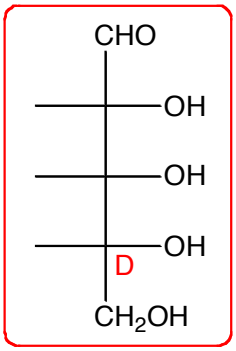
α-D-Glucose
β-D-Glucose
βββ-D-Glucose
ΔΓ-D-Glucose
Fred

6. For the following carbohydrates, draw a circle around all of the D-carbohydrate(s), and draw a rectangle around all of the L-carbohydrate(s). On the two first two lines below the four structures, indicate whether each is an aldose or ketose, and whether each is a pentose or hexose, respectively. On the third line below each structure, construct a compound name from all of these elements. For example, answers might be L-ketopentose or L-aldohexose. Finally, on the fourth line under each structure write the specific name (i.e. D-glucose) for each structure. You should use table 25.1 or other structures named in the book (5th Ed. Brown, Foote, Iverson and Anslyn) to identify these exact sugar names. (You will NOT need to know them for the MCAT).

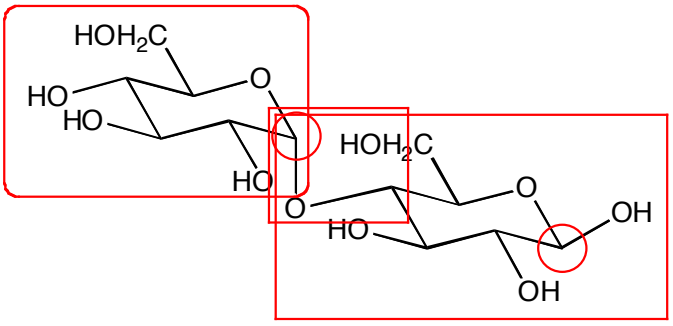






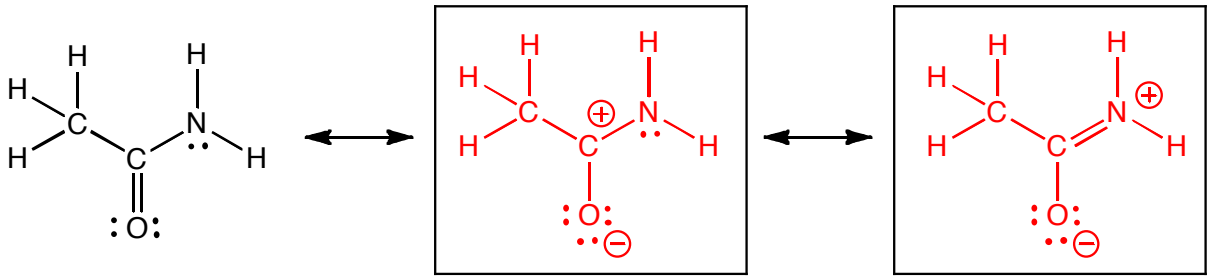


aldose	aldose	ketose	aldose	(aldose or ketose?)
hexose	hexose	hexose	pentose	(pentose or hexose?)
D-aldohexose	L-aldohexose	D-ketohexose	D-aldopentose	(compound name)
D-glucose	L-glucose	D-fructose (pg 1009)	D-ribose	(exact name)

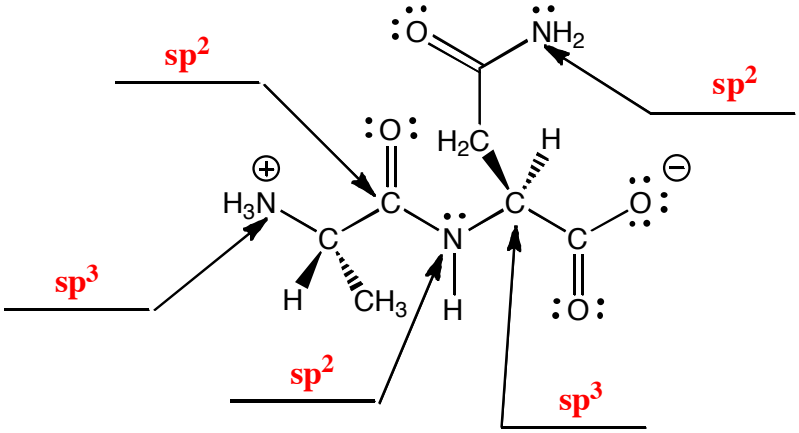


For the disaccharide of glucose on the left, draw a circle around any glucose residue that is/are a. Draw a box around any glucose residue that is/are b. Next, draw a box around the glyocosidic bond linkage. Finally, circle all anomeric carbon atoms.

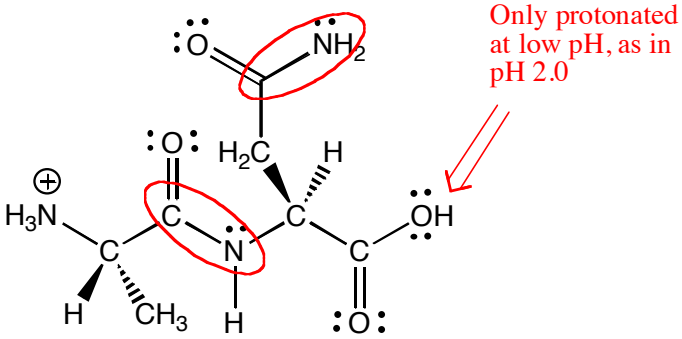
7. Draw the two most important resonance contributing structures of the amide shown below. Be sure to show all lone pairs and formal charges. You do not have to draw arrows on this one.



8. On the lines, indicate the hybridization state of each atom indicated by the arrows.



9. On the following structure **circle all of the C-N bonds that DO NOT ROTATE.**



For the above stucture, is this the appropriate protonation state for pH 2.0, 7.0, or 10.0?

2.0

⟸ Notice This