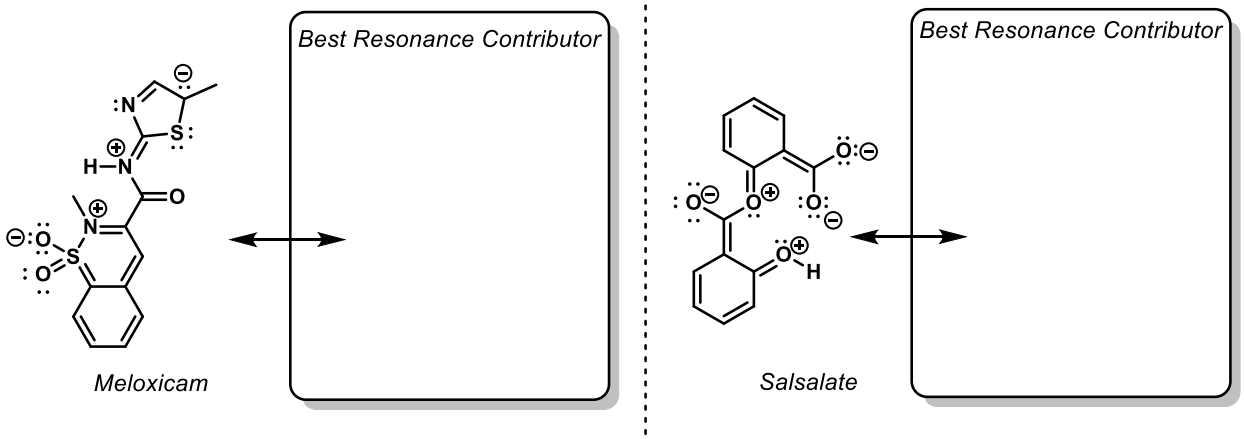
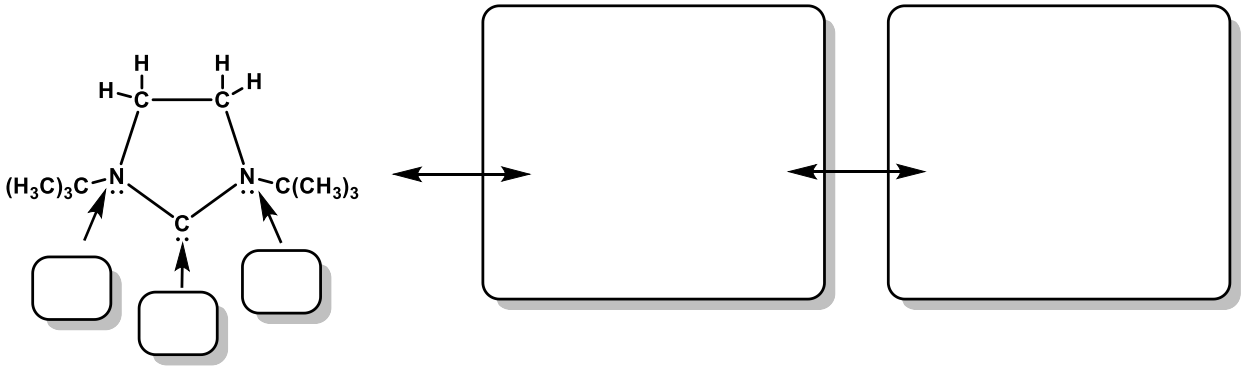
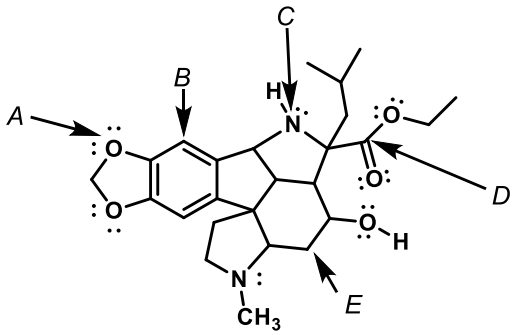
1. ***Resonance.*** Non-steroidal anti-inflammatory drugs (NSAIDs) comprise an important class of pharmaceuticals. Two such compounds are given below; however, the structures given are not how you might see them presented normally. Provide the BEST (most stable) resonance contributor.



2. ***Resonance.*** Carbenes are a class of organic molecules with an uncharged carbon atom with only 6 valence electrons, as shown below. They can bond to transition metals via the lone pair on carbon to make organometallic complexes that often have interesting catalytic properties. Draw the two resonance structures that give all atoms an octet for the molecule below. Given these resonance structures, suggest what the hybridization is at the indicated atoms.



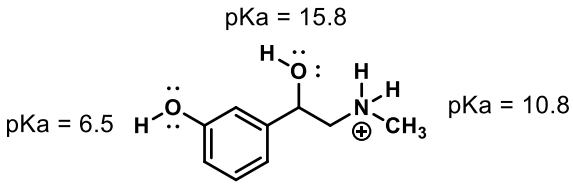
3. ***Hybridization / Geometry.*** Gracilamine is an isolated natural product from plants in the *Amaryllidacaeae* family, located on certain mountains in Turkey. Fill in the correct hybridization and molecular geometry of the indicated atoms.



Gracilamine

	Hybridization	*Geometry*
A		
B		
C		
D		
E		

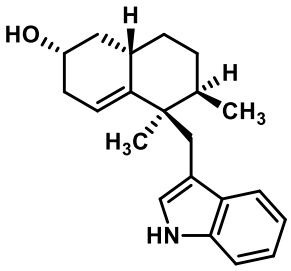
4. ***Acid / Base.*** Phenylephrine (below) is a common ingredient in cold and flu medicine. Under physiological conditions (i.e. pH ~7), phenylephrine exists as a "zwitterion" (*contains charged atoms that cancel each other, giving an overall neutral molecule*). Given this information and the pKa's below, draw the main zwitterionic form at pH = 7.



Phenylepherine under acidic conditions

Zwitterionic form of phenylepherine

5. ***Stereochemistry / Isomers.*** Polyathenol (below) is a natural product isolated from extracts of a root that grows in West Africa with potential for activity against *Staphylococcus aureus*. Please answer the following questions on the stereocenters found in Polyathenol.



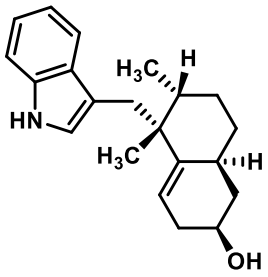
Polyathenol

A) How many stereocenters exist in Polyathenol?

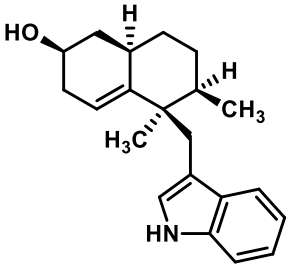
B) How many stereoisomers are possible?

C) Define each of the stereocenters as either R or S.

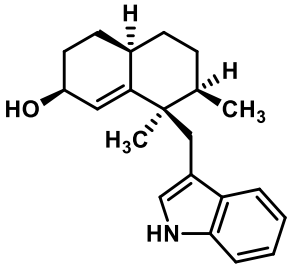
There are three molecules below which are in some way related to Polyathenol. Circle the description that best matches the relationship between Polyathenol and each molecule.



Enantiomers
Diastereomers
Constitutional Isomers
Identical Molecules



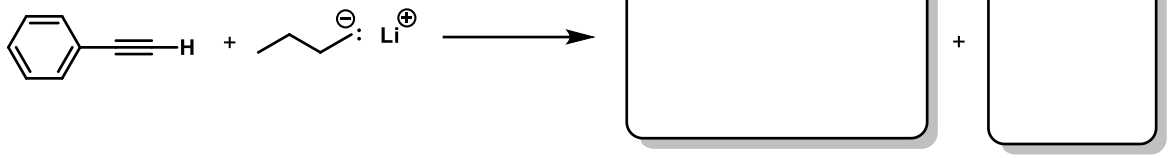
Enantiomers
Diastereomers
Constitutional Isomers
Identical Molecules



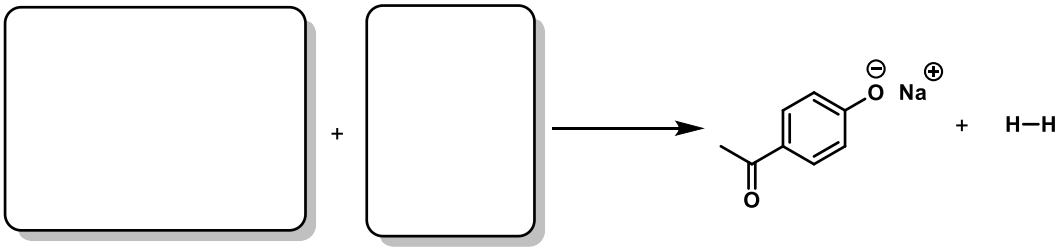
Enantiomers
Diastereomers
Constitutional Isomers
Identical Molecules

6. ***Acid / Base.*** Fill in the missing products for the following acid / base reactions. For the final reaction, use the pKa values supplied to determine the K_{eq} of the reaction.

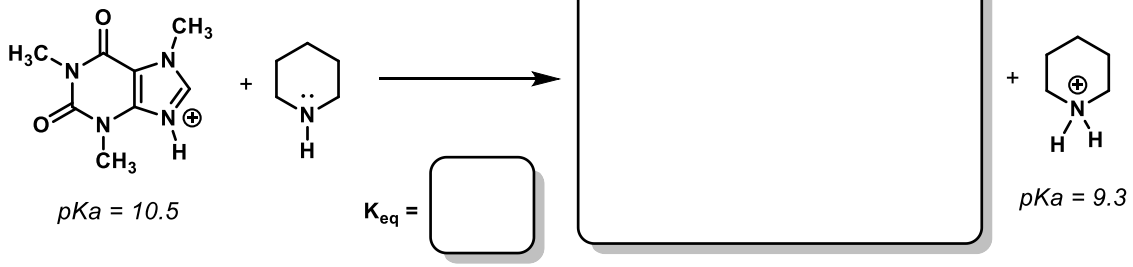
A)



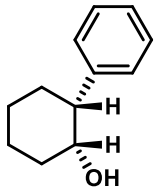
B)



C)



7. ***Conformational Analysis.*** Molecule **1** was used in *J. Org. Chem.* **2012**, *77*, 1722. In the first box, draw the most stable chair structure for Molecule **1**. In the second box, draw a diastereomer of Molecule **1**. Finally, which of these two chair structures is more stable?

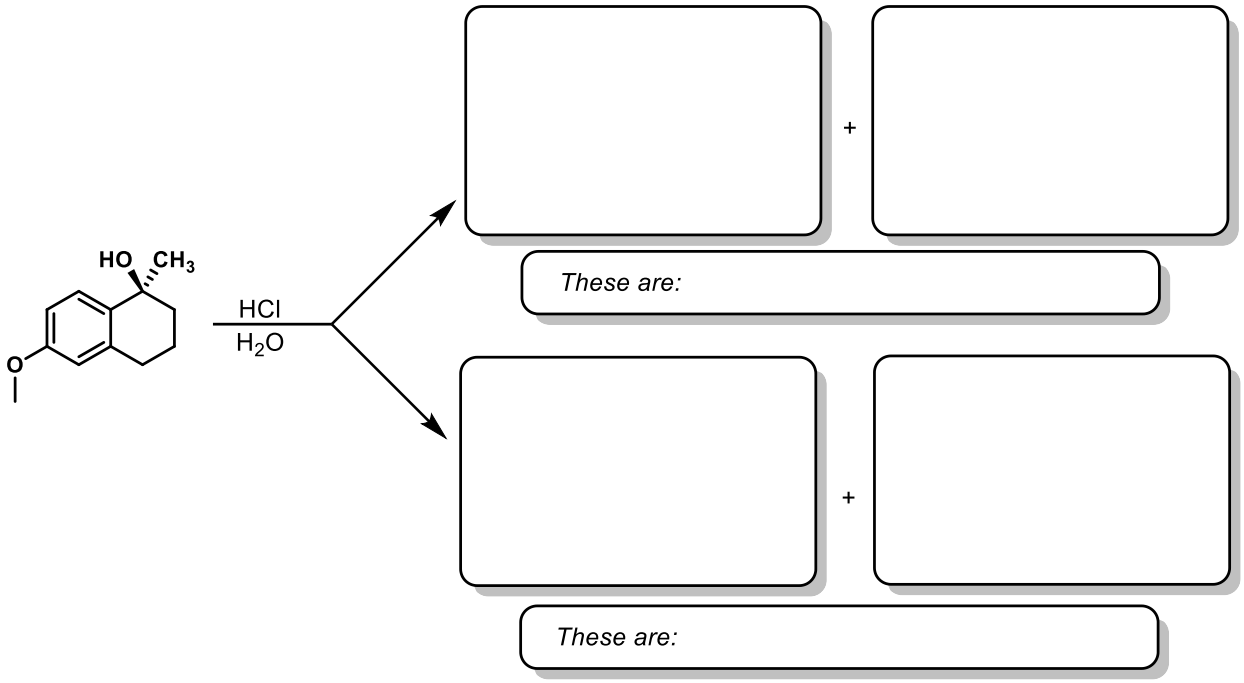


Molecule 1

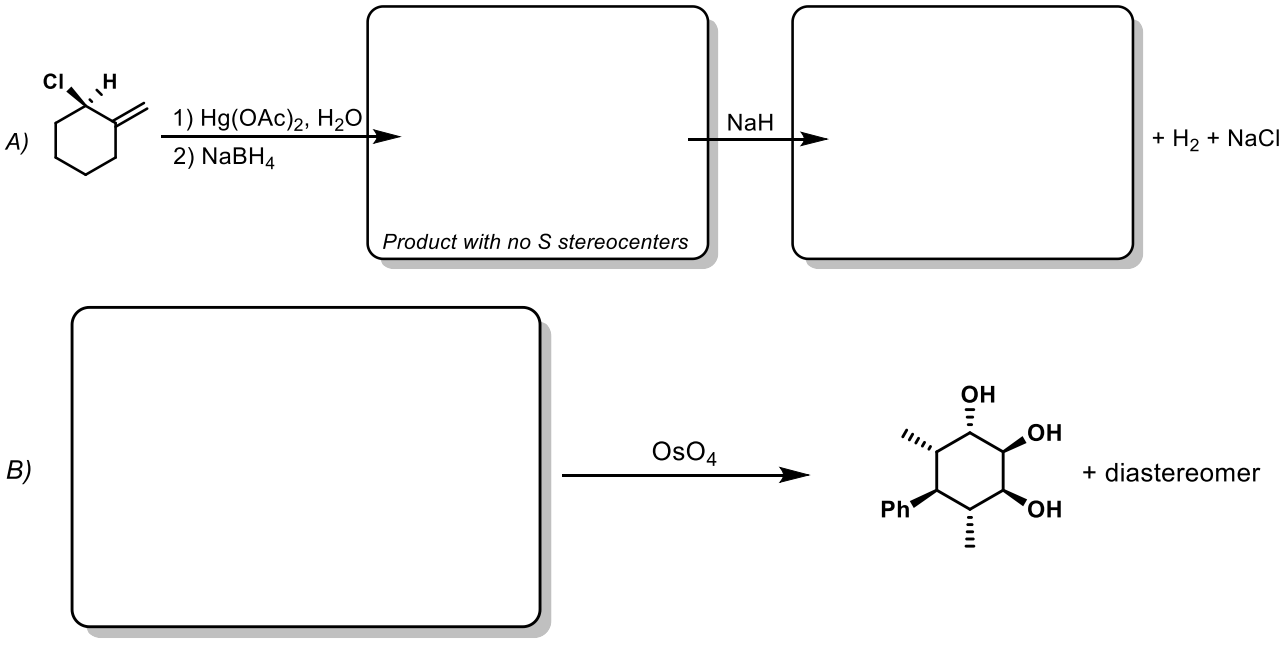
*A) Most Stable Chair Structure of **1***

*B) Diastereomer of **1***

8. ***Substitution / Elimination.*** Fill in the 4 possible products from the reaction below. In the boxes underneath each set of products, describe the relationship that exists between them.



9. ***Addition to π Bonds.*** Fill in the missing starting materials or products for the following reactions.



10. ***Substitution.*** Fill in the missing products below.