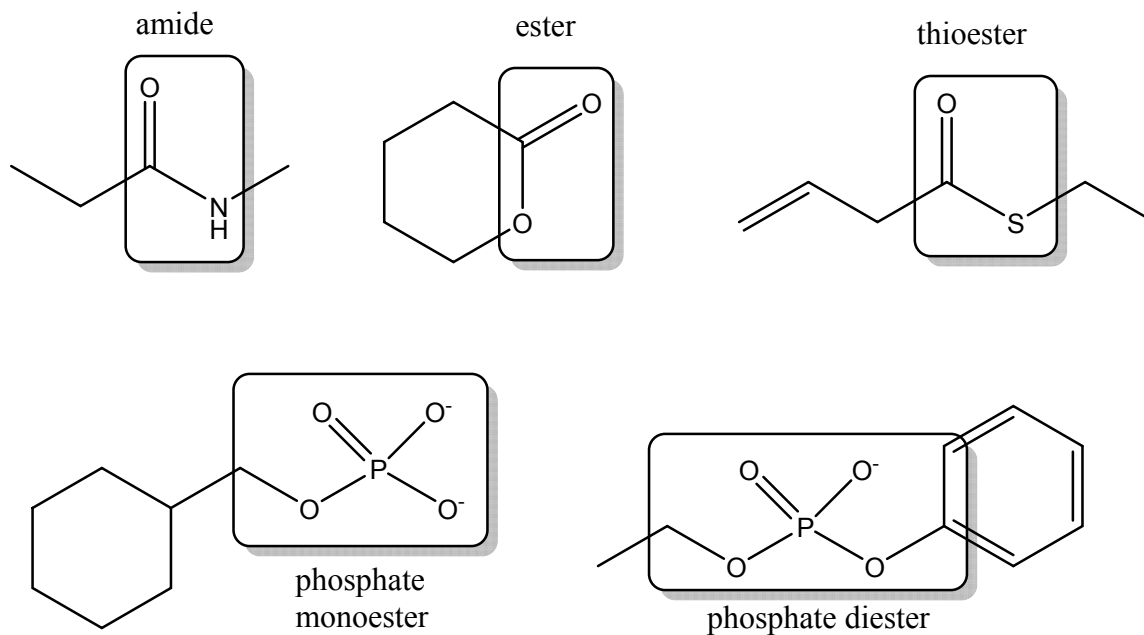


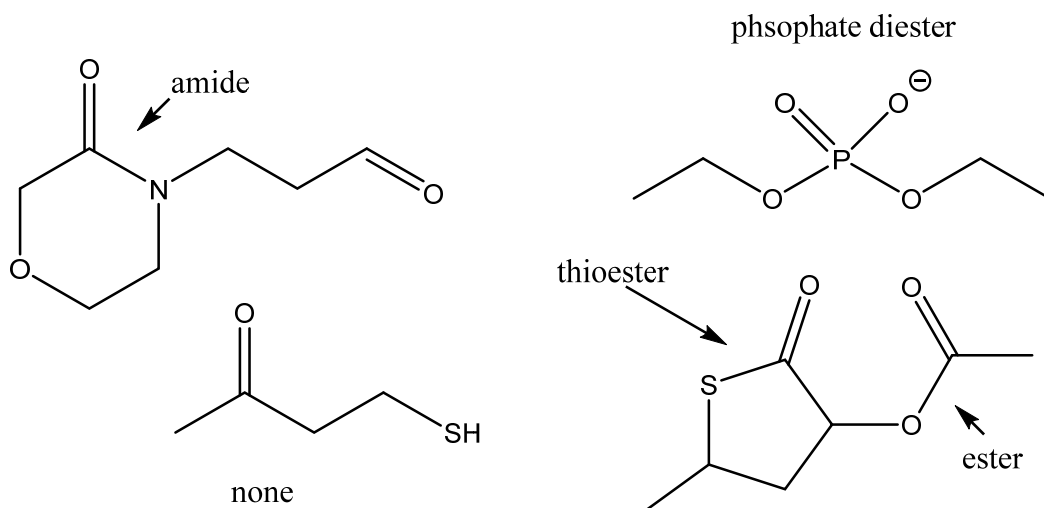
### Discussion Exercise 3: Hydrolysis Reactions

#### Key

Problem 1: Draw example molecules that contain amide, ester, thioester, phosphodiester, and phosphoanhydride functional groups.

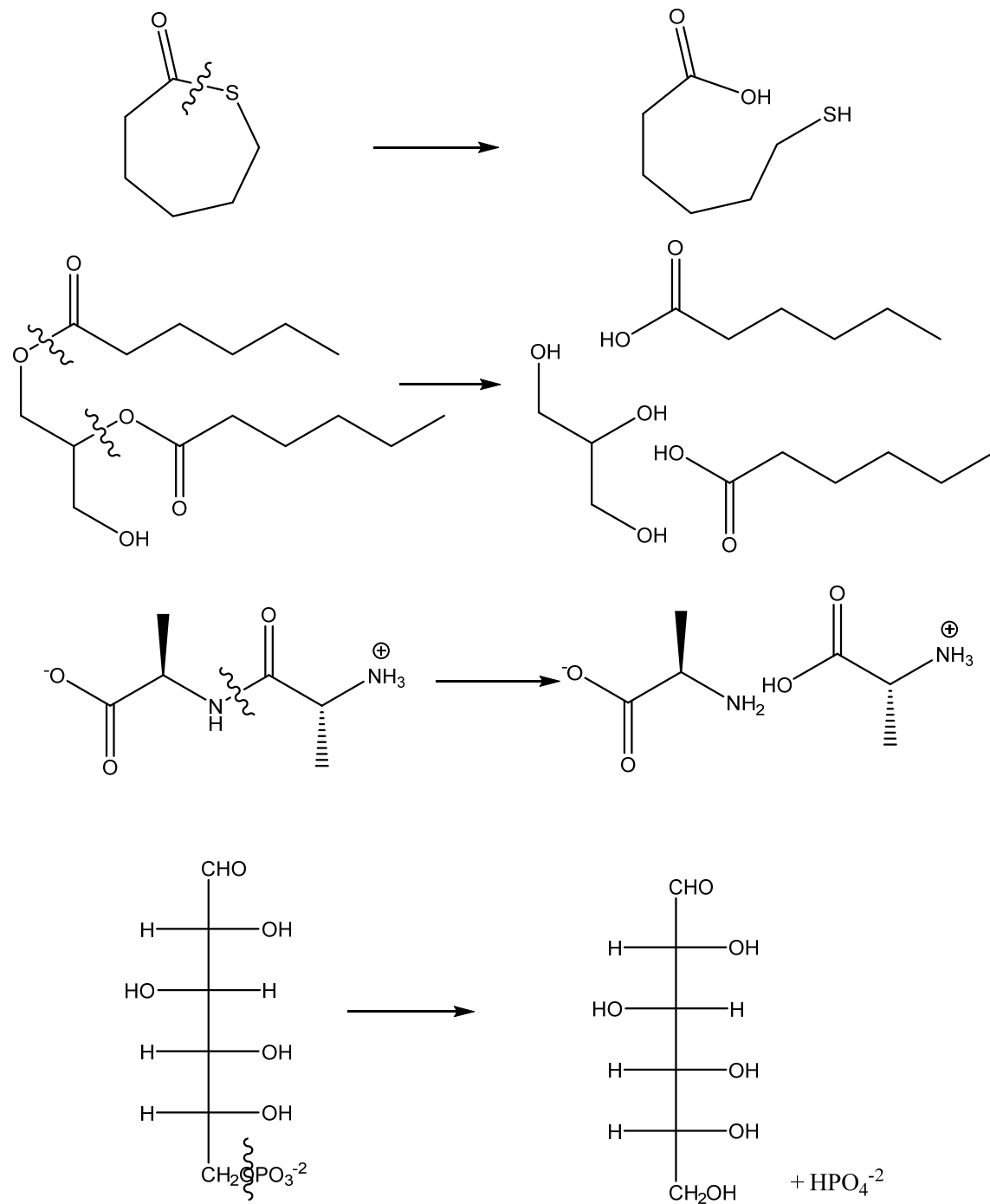


Problem 2: In the molecules below, label all hydrolysable functional groups.

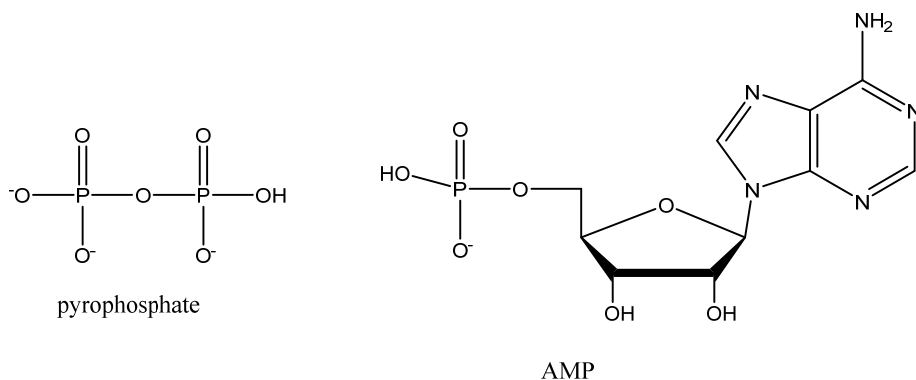


Problem 3: Predict the products of these hydrolysis reactions.

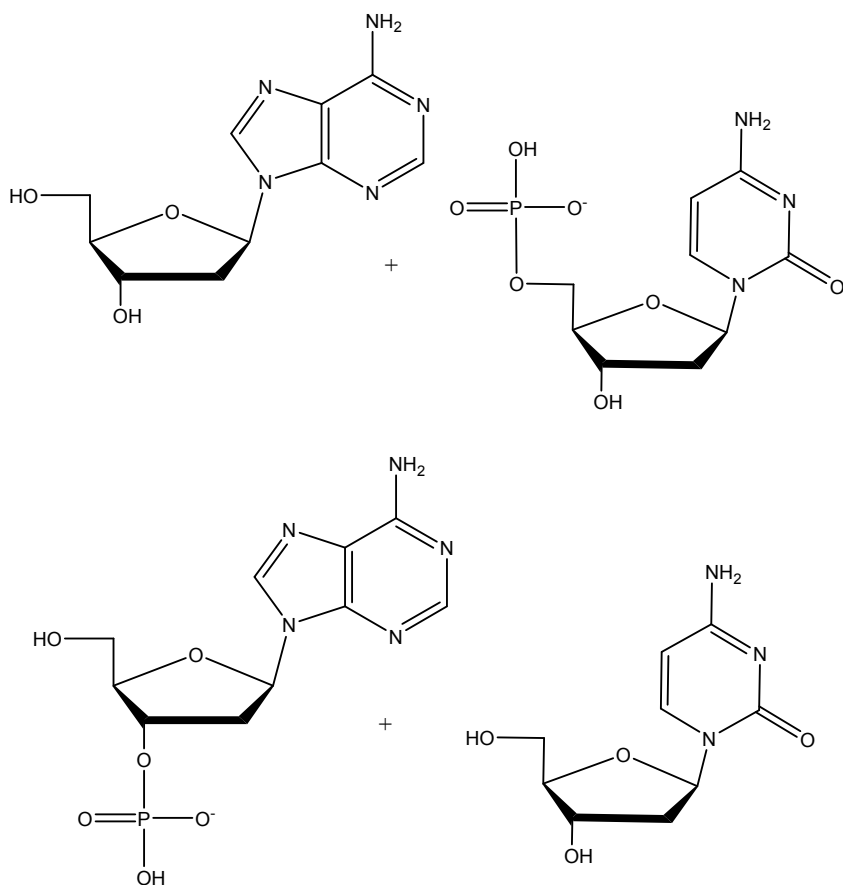
The compounds below are not written in their typical ionization states at pH 7. All the carboxylic acids would be ionized.



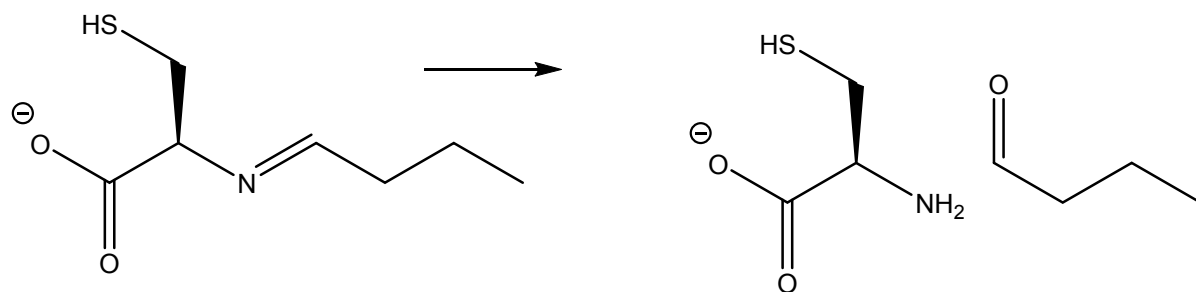
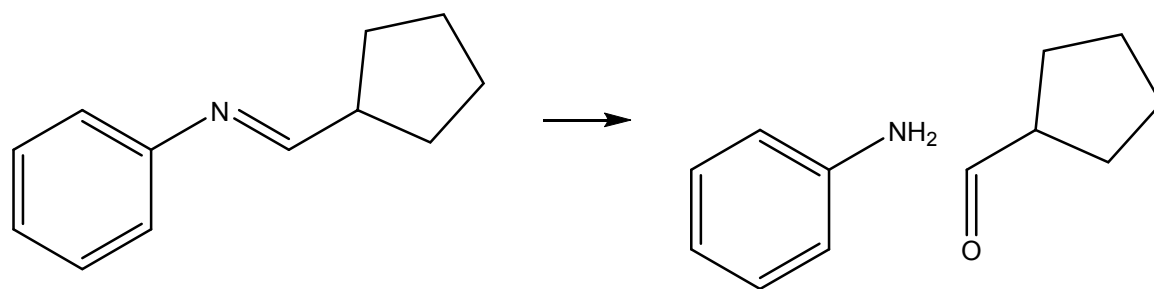
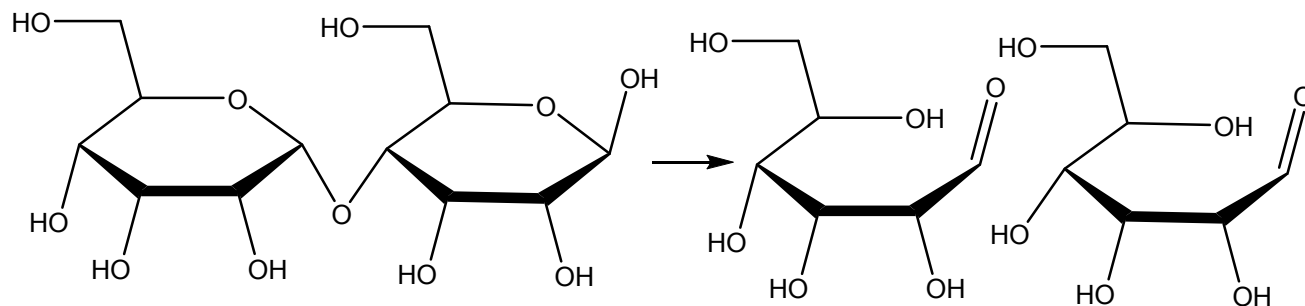
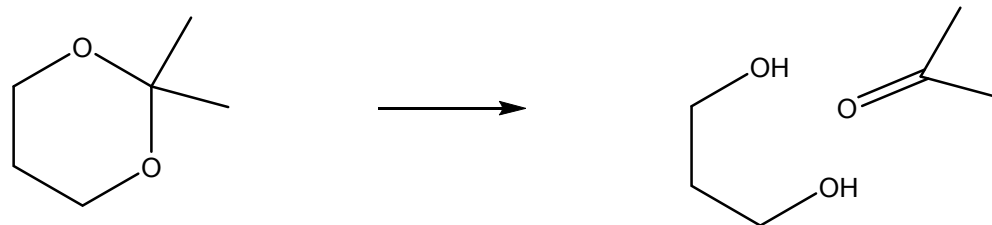
**Problem 4:** A phosphoanhydride bond of ATP can be hydrolyzed to give AMP and pyrophosphate. Draw the structure of pyrophosphate in its major ionization state at pH 7. (pKa values 1-4 for pyrophosphate are 0.91, 2.10, 6.70. and 9.32.)



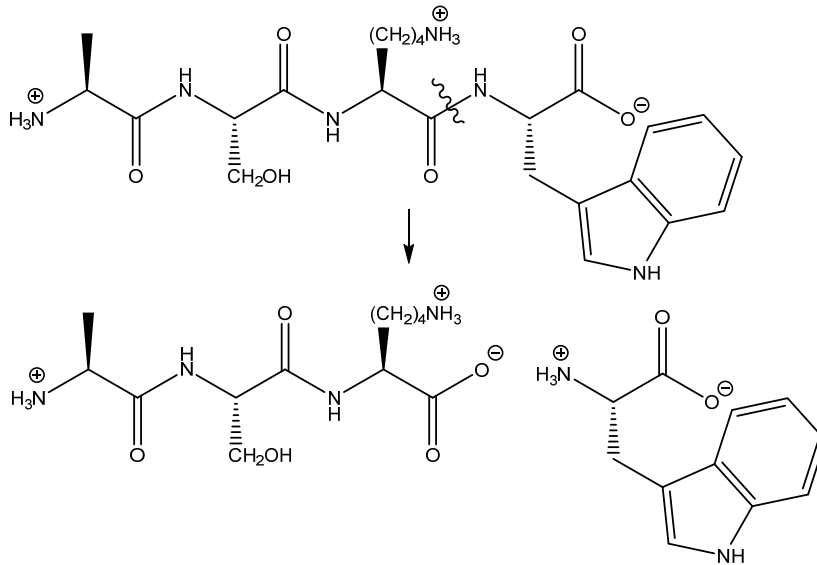
**Problem 5:** Phosphodiesterases can be hydrolyzed on either side of the phosphate functional group to give a phosphate monoester and an alcohol. Draw the two possible products that form when the diester is hydrolyzed.



Problem 6: Predict the hydrolysis products of each of these compounds.



**Problem 7:** Proteases are enzymes that hydrolyze polypeptides. Trypsin is a protease that specifically hydrolyzes the peptide bond on the carboxy side of positively charged side chains. Draw the full structure of the trypsin hydrolysis products of ASKW.



**Problem 8:** Nucleases are enzymes that hydrolyze oligonucleotides. Draw the full structures of the hydrolysis products of pApCpUp if the nuclease only cuts the 3' phosphodiester linkage after purines.

